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Uchida

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(54) **PRINTING APPARATUS AND CONTROL METHOD**

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B41J 2/005 (2006.01)

(52) **U.S. Cl.**
CPC ***B41J 2/0057*** (2013.01); ***B41J 2/01*** (2013.01); *B41J 2002/0052* (2013.01); *B41J 2002/012* (2013.01)

(58) **Field of Classification Search**
CPC B41J 2/0057; B41J 2002/012
USPC 347/104
See application file for complete search history.

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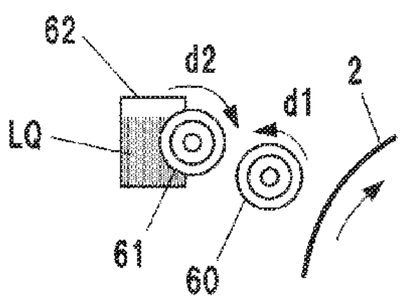
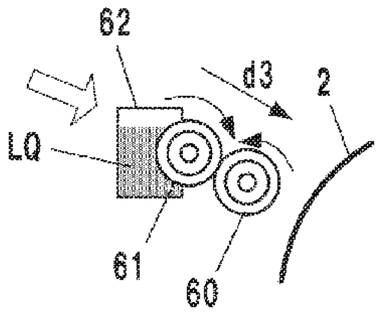
(57) **ABSTRACT**

A printing apparatus includes a transfer drum configured to rotate while supporting a plurality of transfer members on each of which an image is formed by discharging ink from a printhead, a rotating member configured to apply a processing liquid while being pressed against each of the plurality of transfer members, and a concave portion formed lower than a surface of each of the plurality of transfer members between the adjacent transfer members. In addition, the printing apparatus includes a driving unit configured to driven-rotate the rotating member in accordance with rotation of the transfer drum in a state in which the rotating member is pressed against the plurality of transfer members, and driving-rotate the rotating member in a state in which the rotating member faces the concave portion.

11 Claims, 14 Drawing Sheets



ST1



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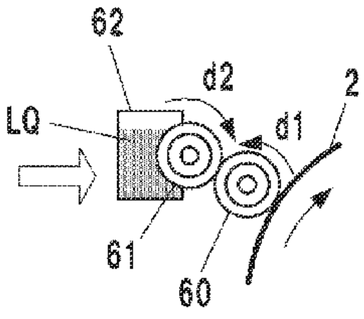
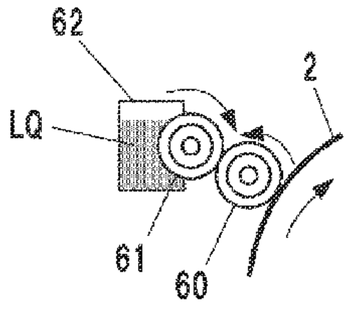
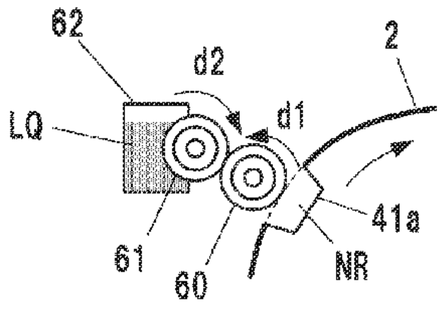


ST3

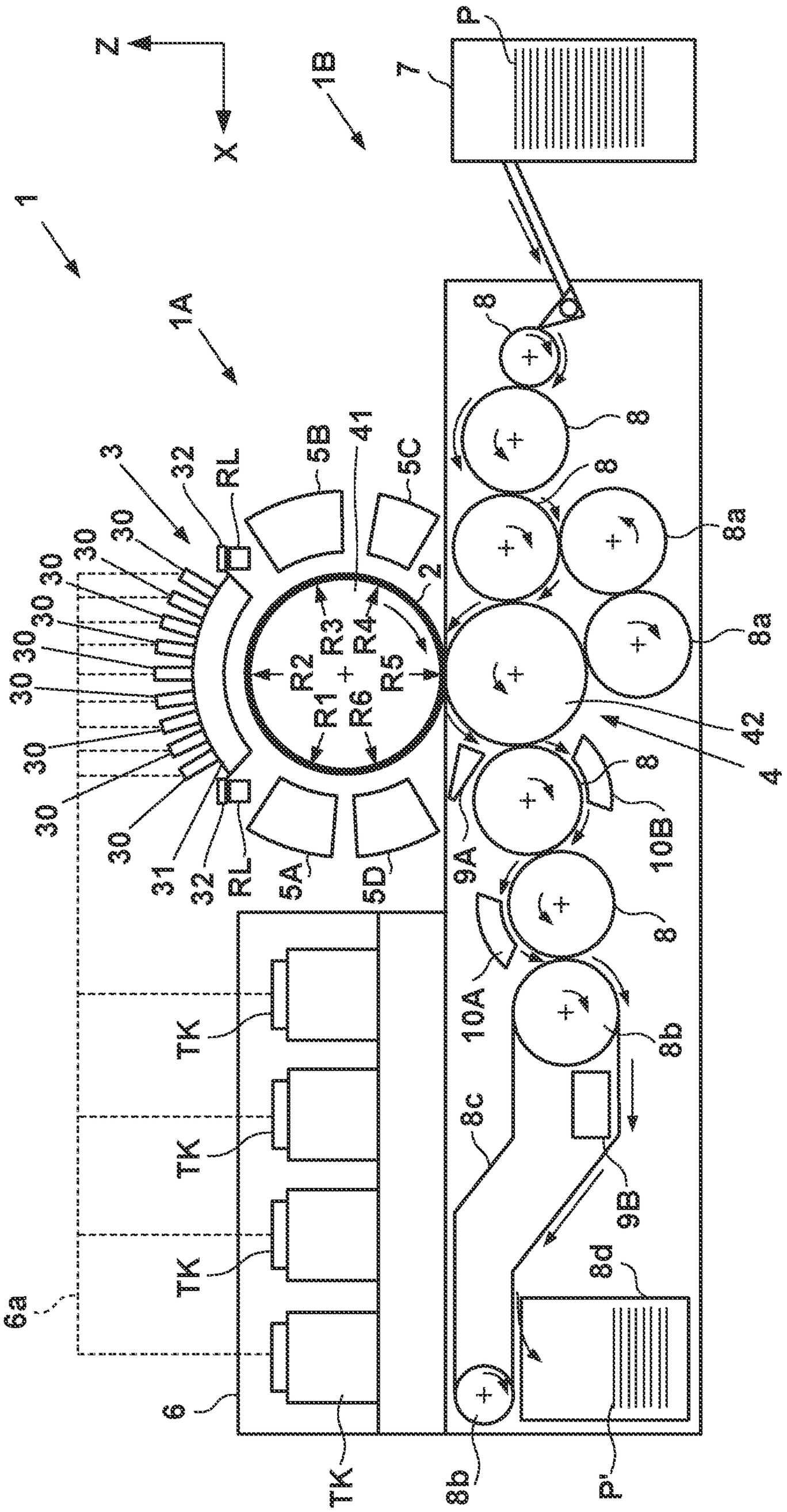


ST4



ST5

FIG. 1


Z
X
1
1A
1B
7
P
8
8a
8b
8c
8d
8B
9A
9B
10A
10B
2
3
4
41
42
5A
5B
5C
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31
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R1
R2
R3
R4
R5
R6

FIG. 2

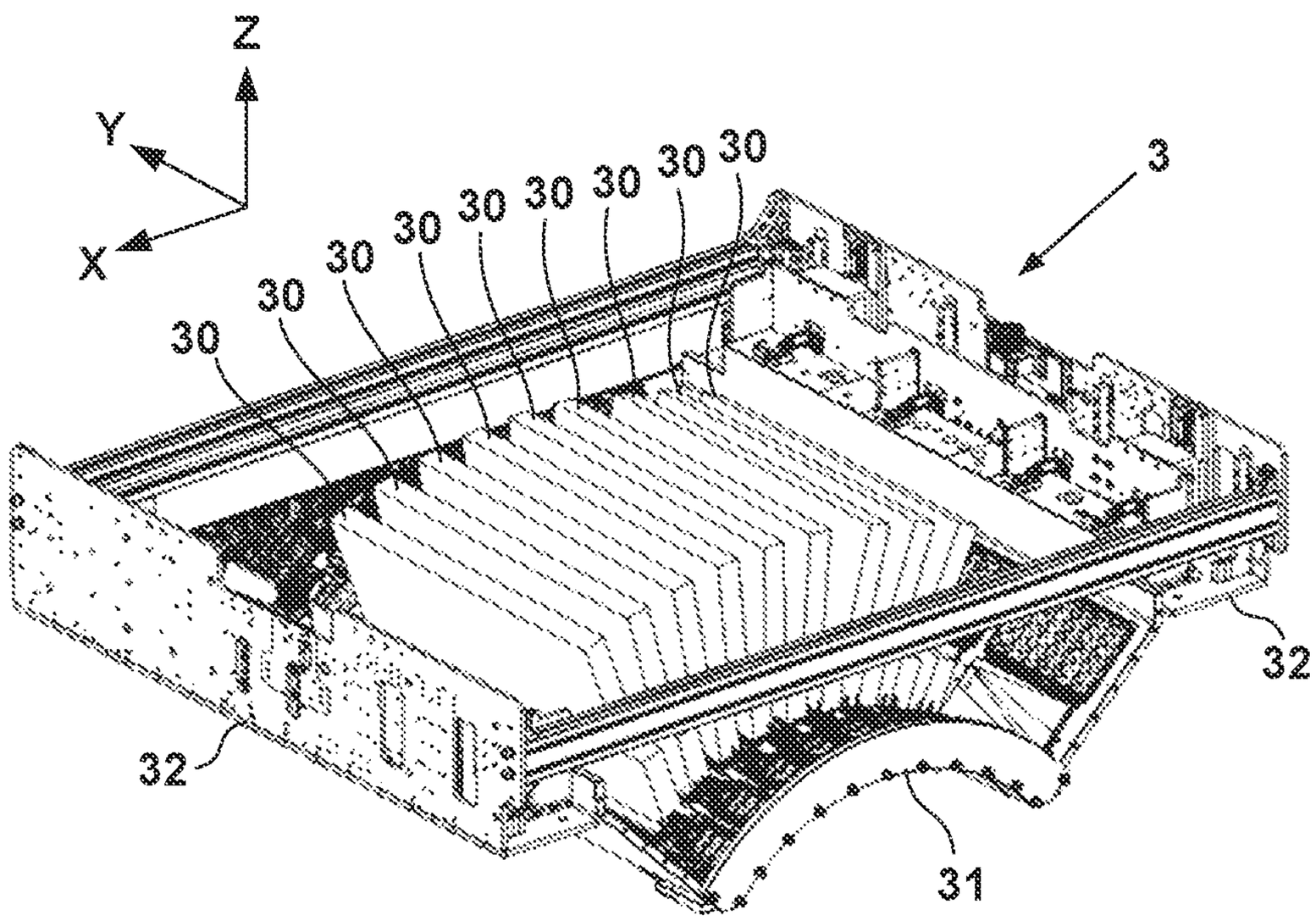


FIG. 3

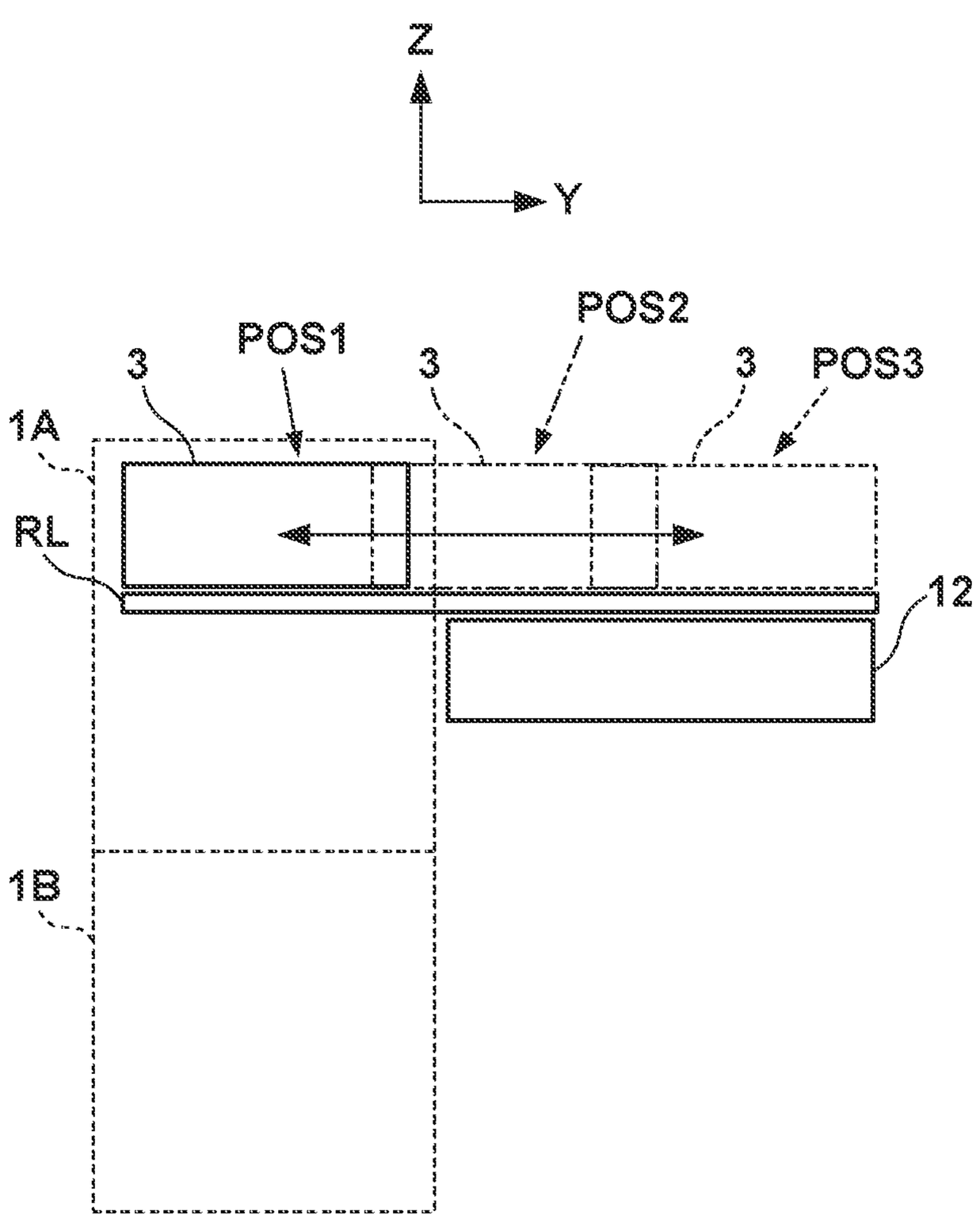


FIG. 4

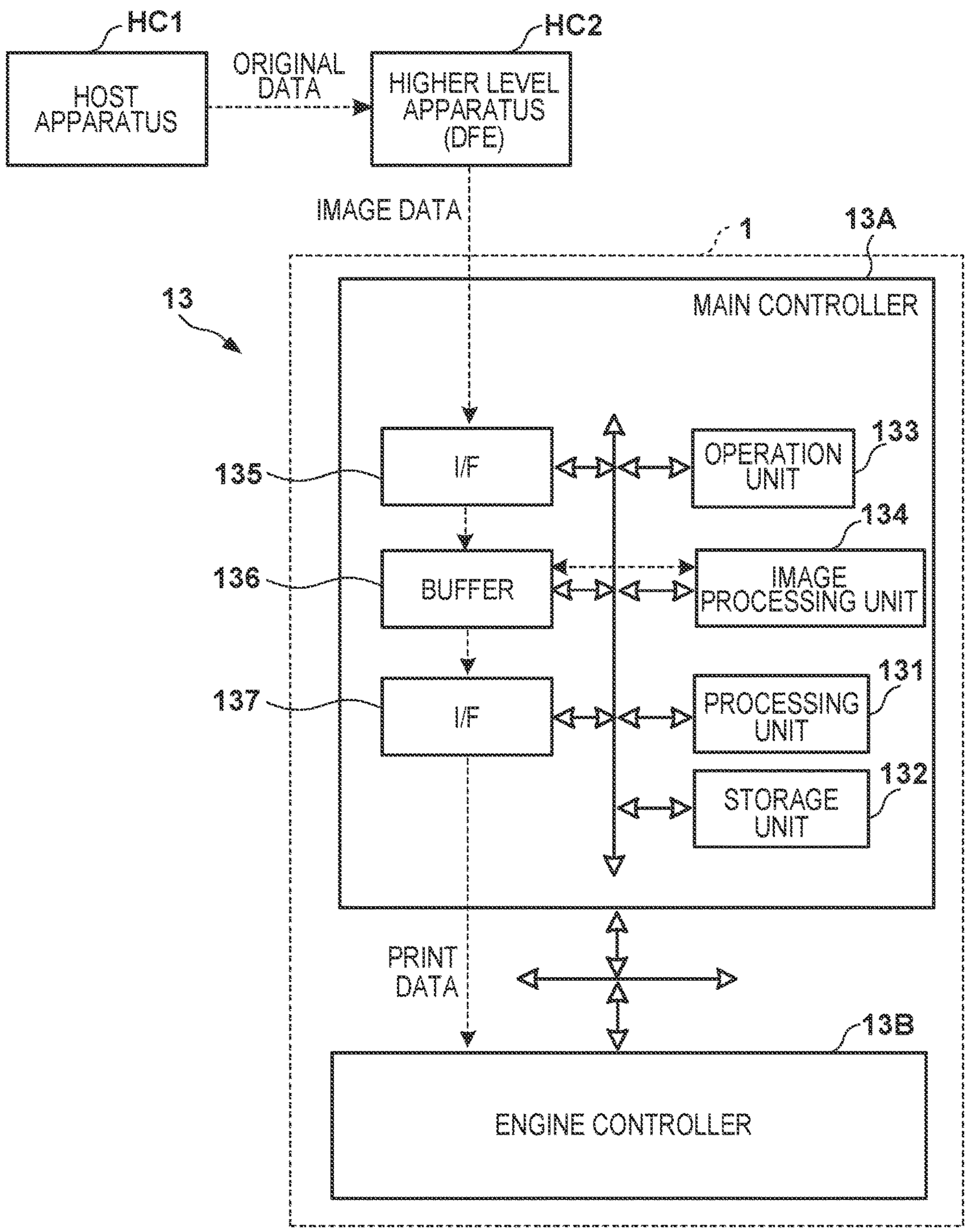

HC1
HOST APPARATUS
ORIGINAL DATA
HC2
HIGHER LEVEL APPARATUS (DFE)
IMAGE DATA
1
13A
13
MAIN CONTROLLER
135
I/F
133
OPERATION UNIT
134
136
BUFFER
IMAGE PROCESSING UNIT
137
I/F
131
PROCESSING UNIT
132
STORAGE UNIT
PRINT DATA
13B
ENGINE CONTROLLER

FIG. 5

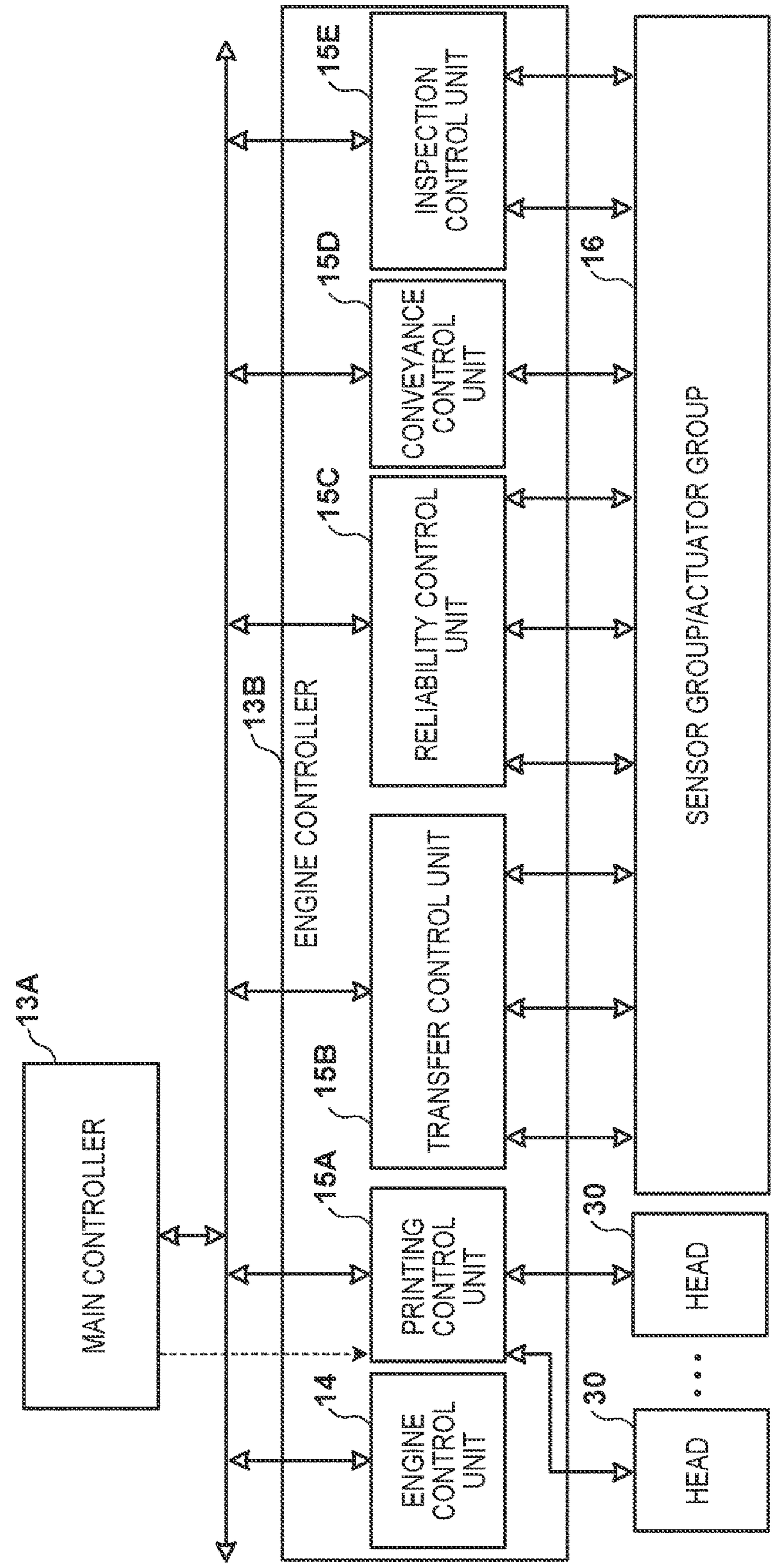

13A
MAIN CONTROLLER
13B
ENGINE CONTROLLER
14
ENGINE CONTROL UNIT
15A
PRINTING CONTROL UNIT
15B
TRANSFER CONTROL UNIT
15C
RELIABILITY CONTROL UNIT
15D
CONVEYANCE CONTROL UNIT
15E
INSPECTION CONTROL UNIT
16
SENSOR GROUP/ACTUATOR GROUP
30
HEAD
HEAD
30
...

FIG. 6

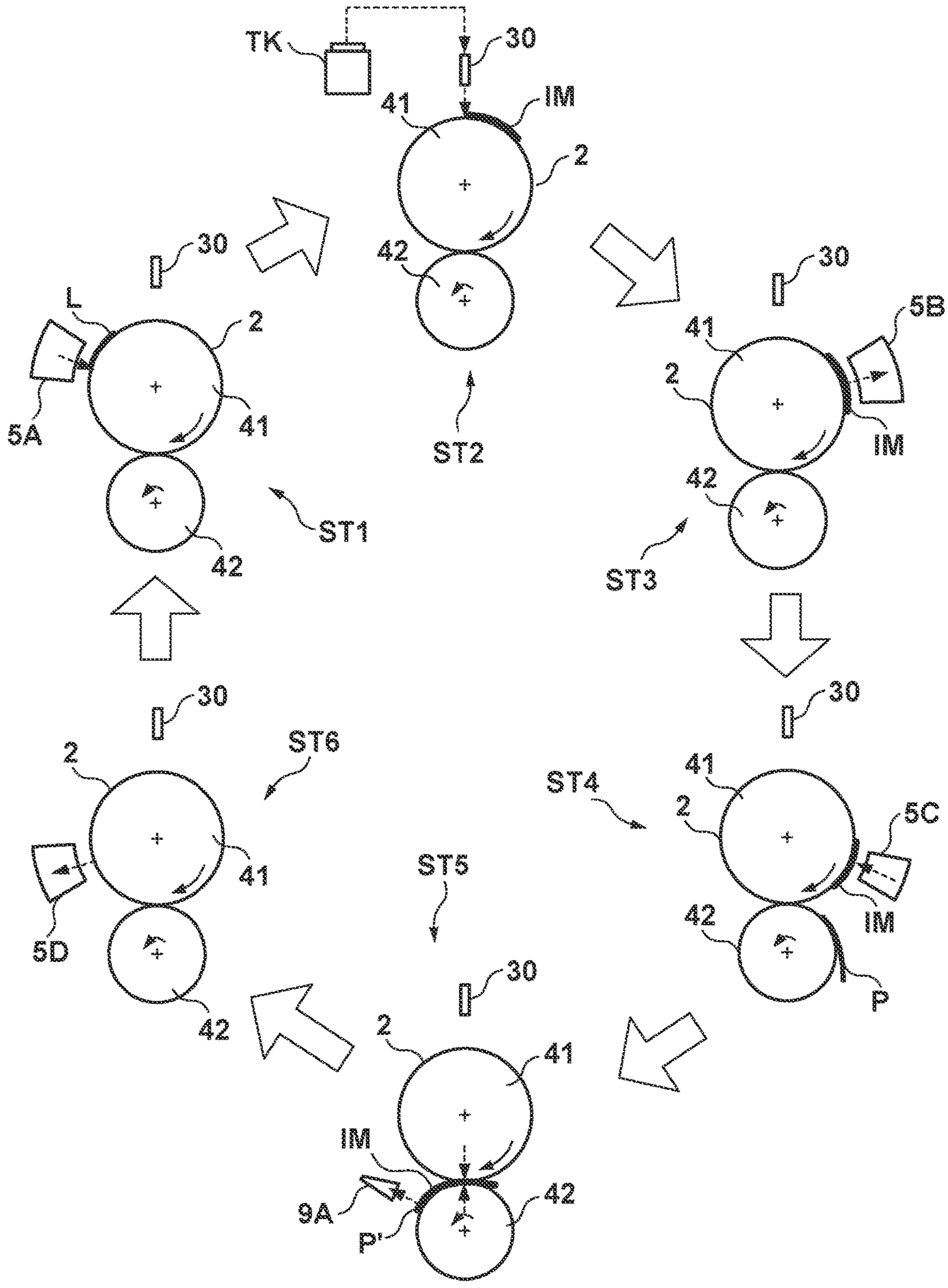


FIG. 7

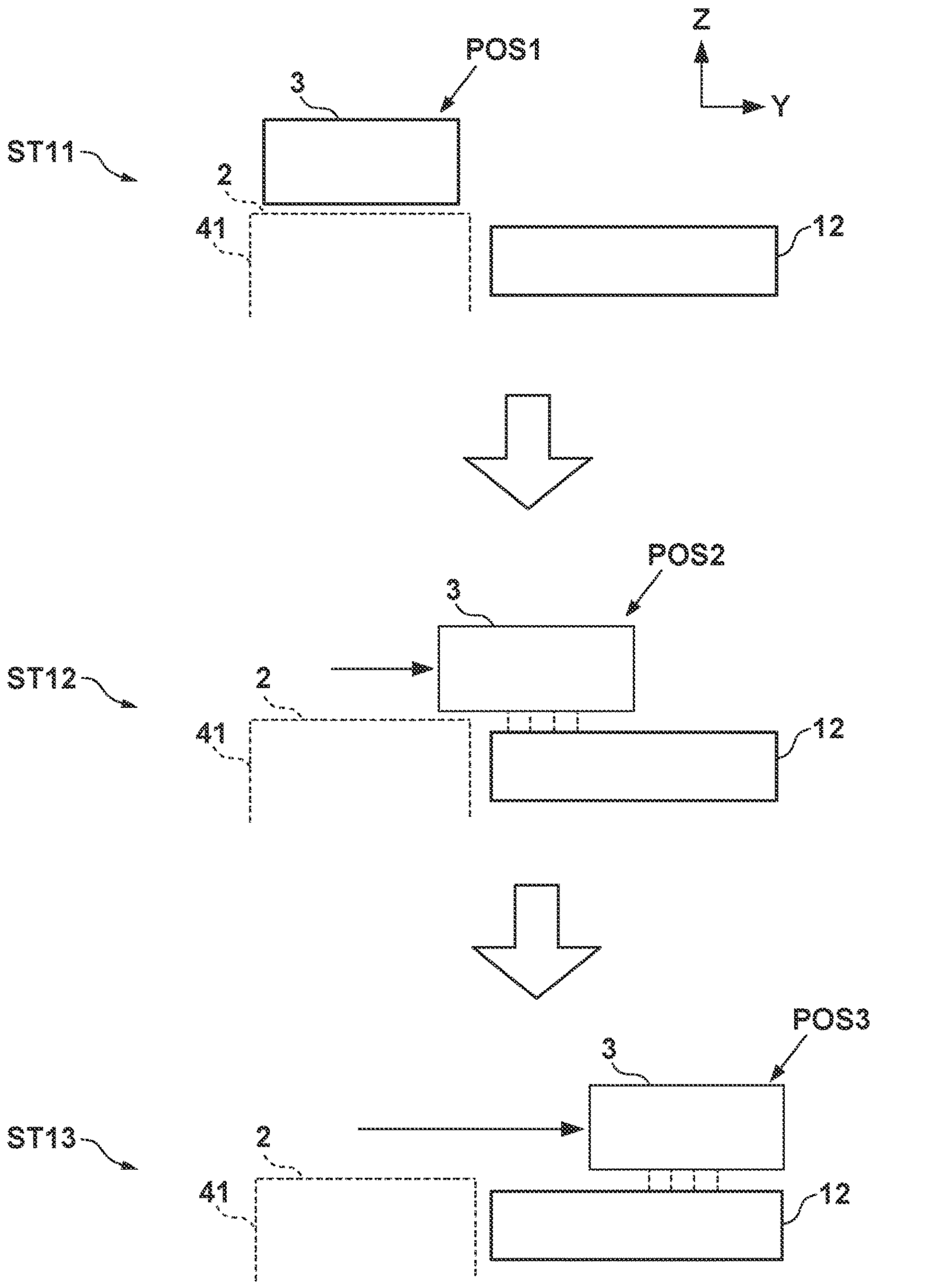


FIG. 8A

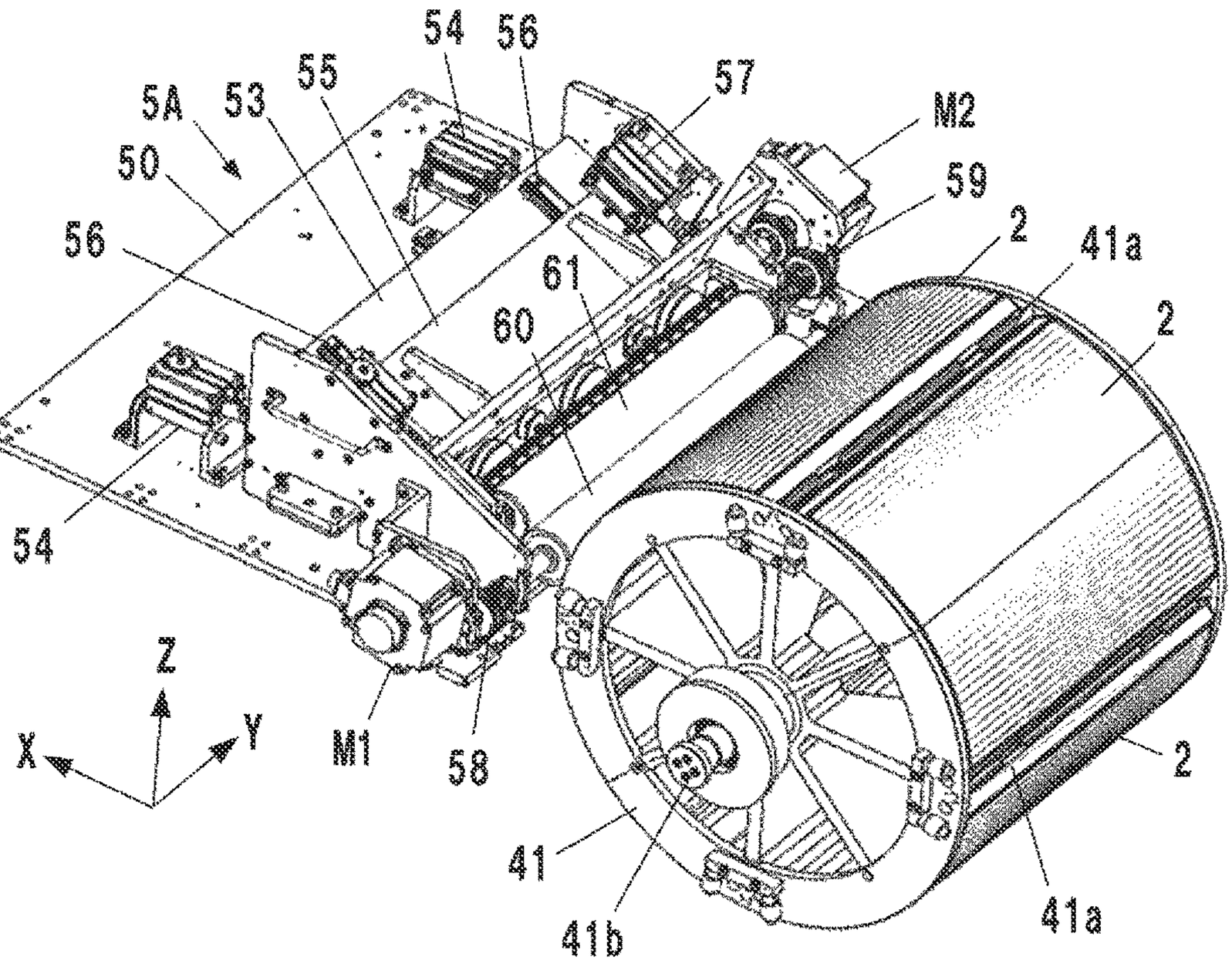

54
56
55
57
5A
53
M2
50
59
56
2
41a
61
60
2
54
Z
X
Y
M1
58
2
41
41b
41a

FIG. 8B

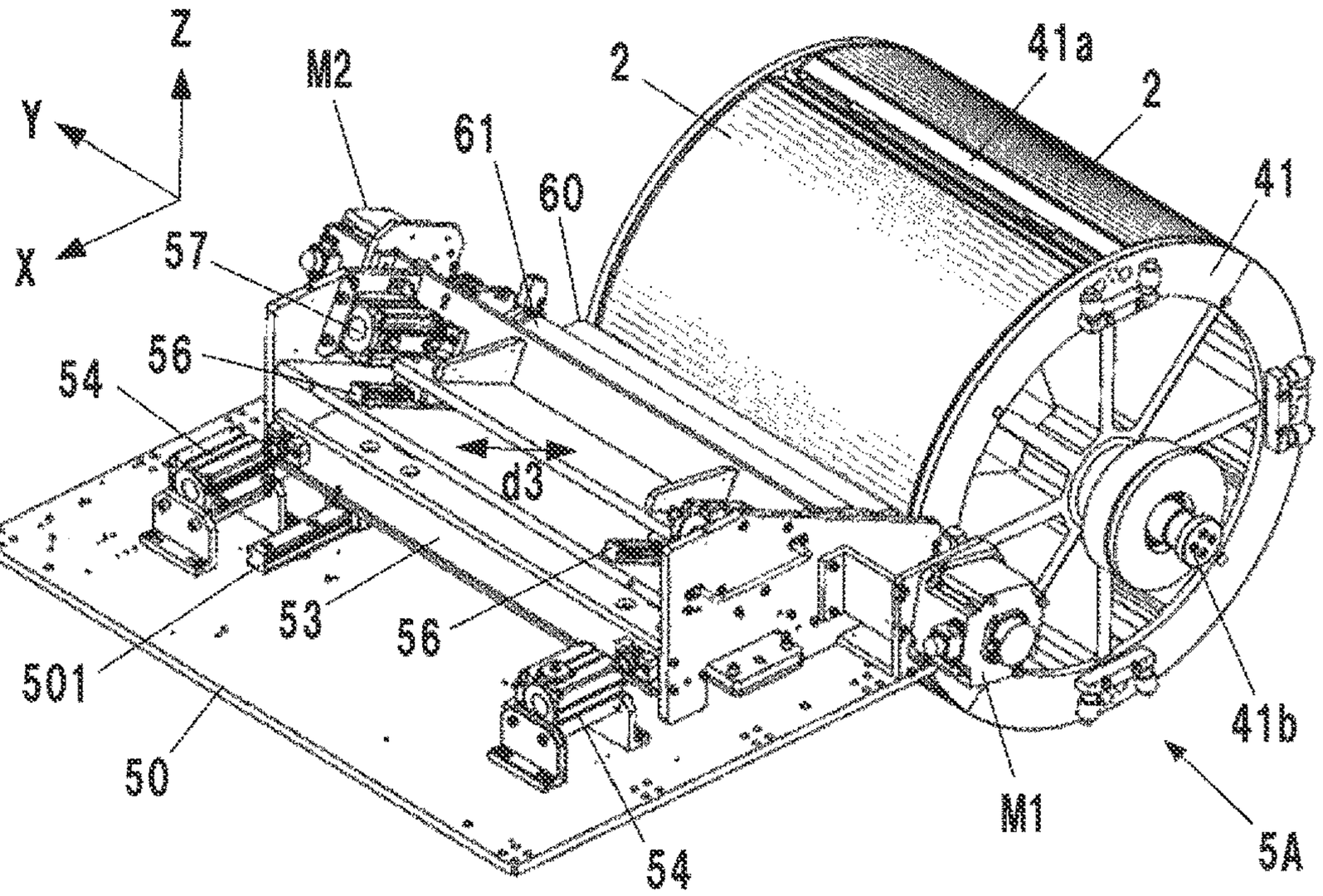

Z
Y
X
M2
61
60
2
41a
2
41
57
56
54
d3
53
56
501
50
54
M1
41b
5A

FIG. 9

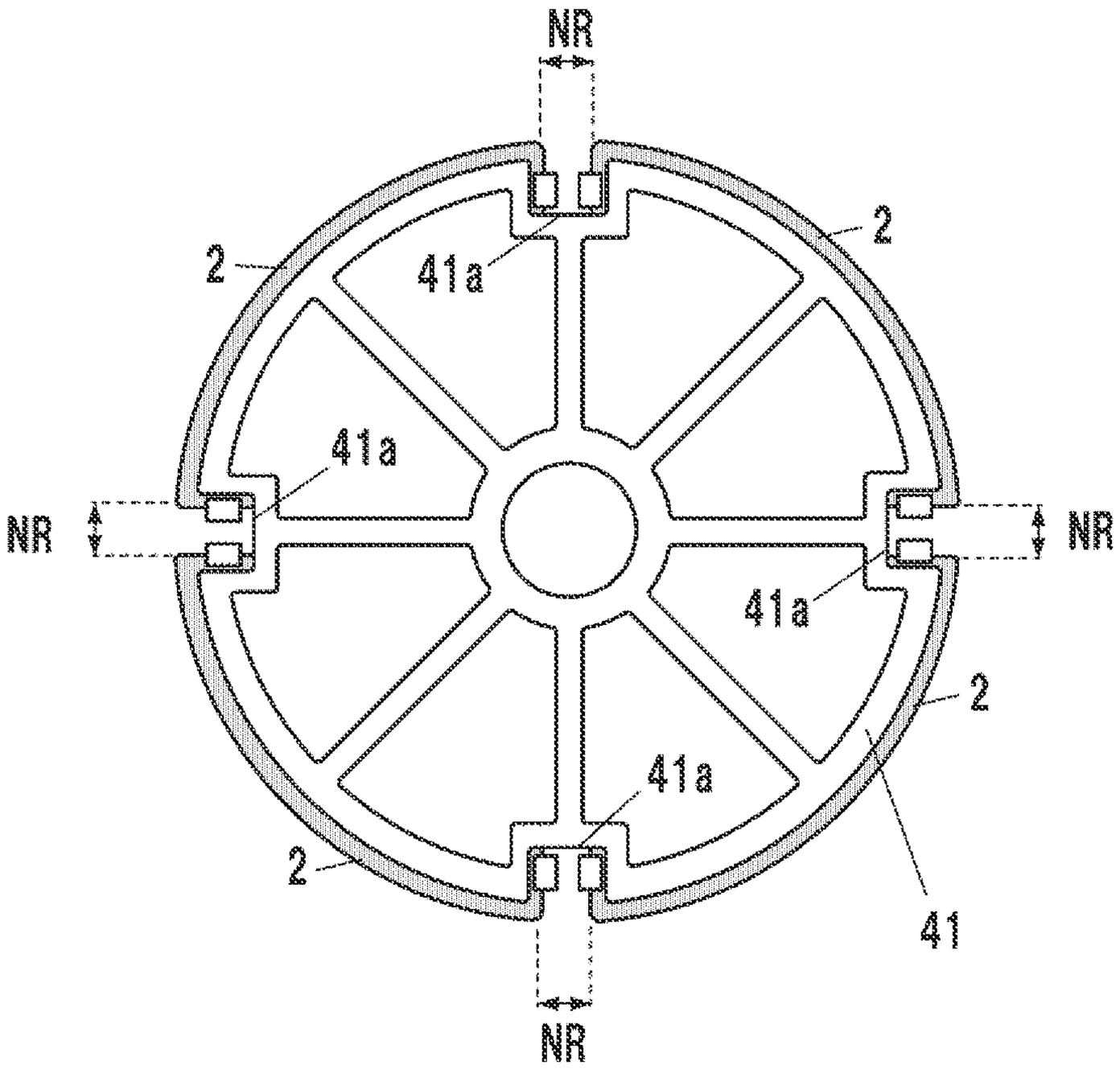


FIG. 10A

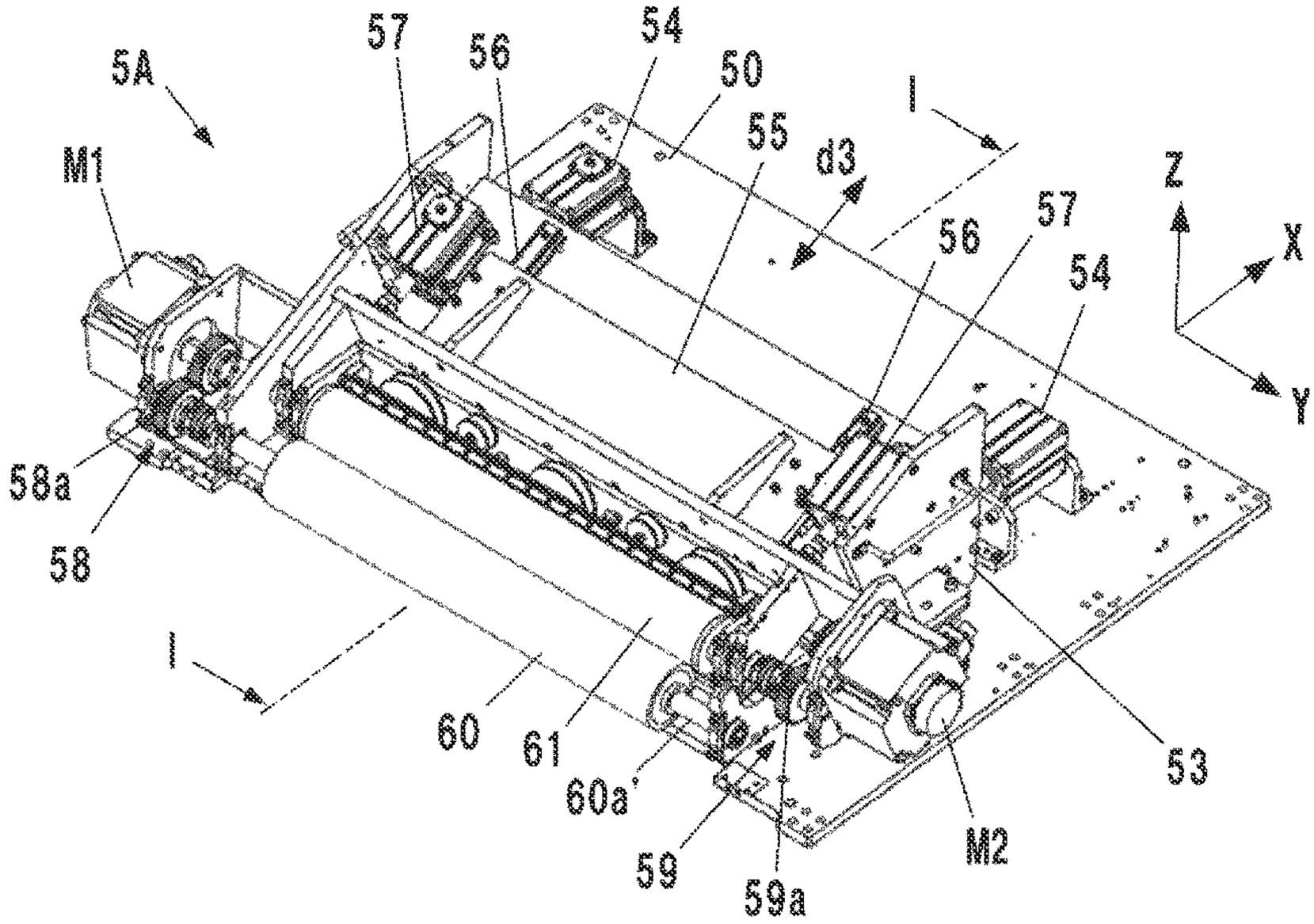


FIG. 10B

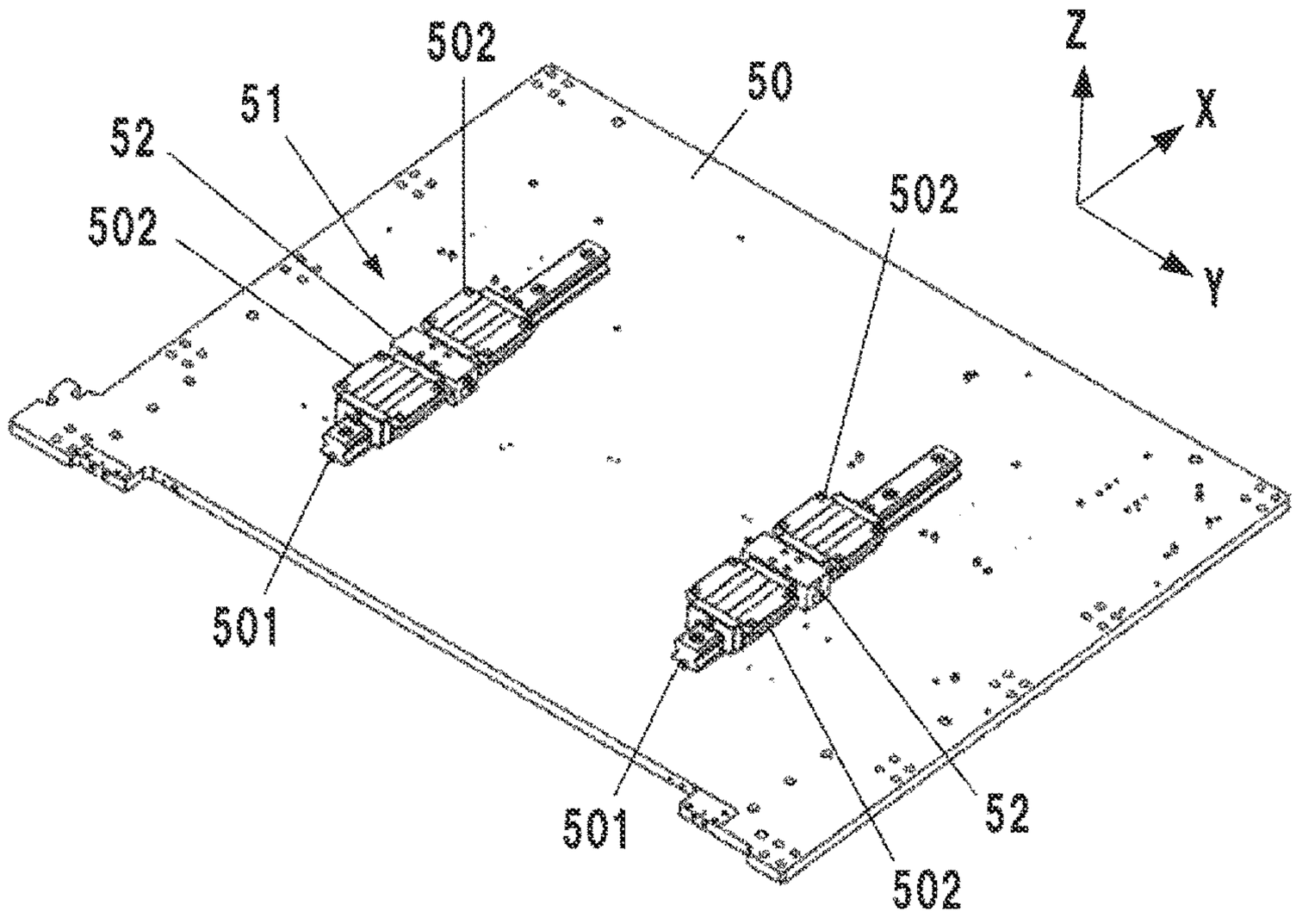


FIG. 11

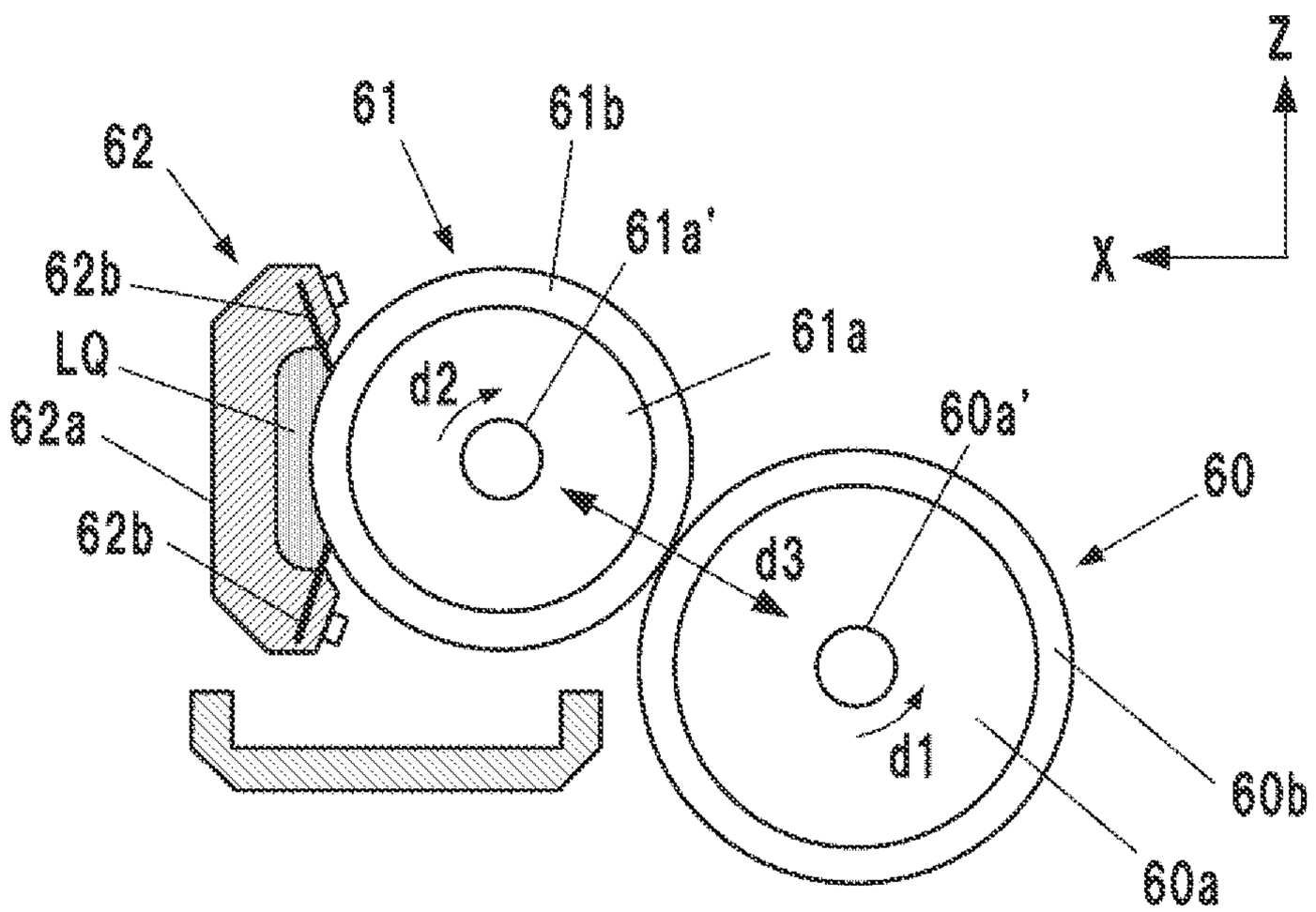


FIG. 12A

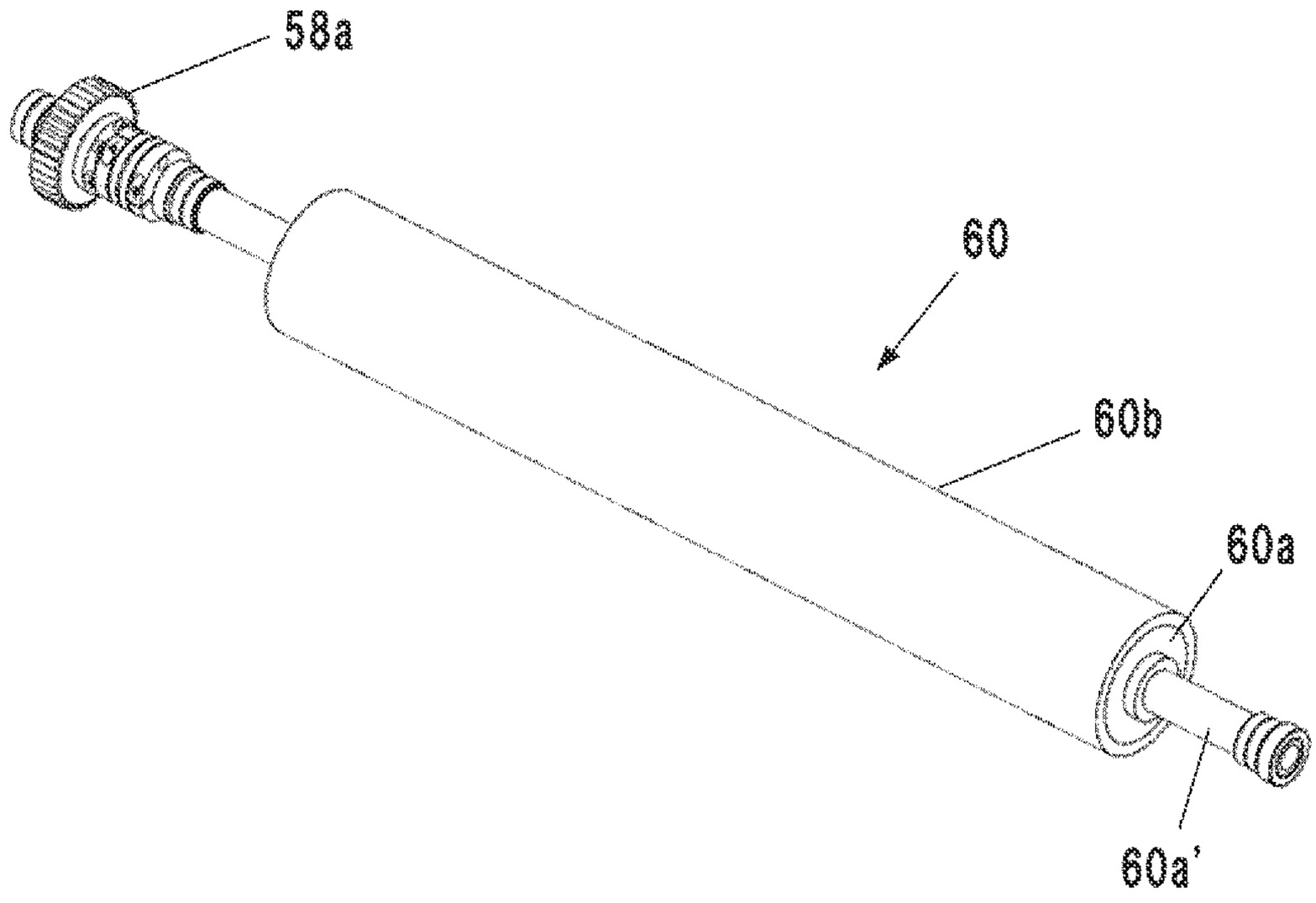


FIG. 12B

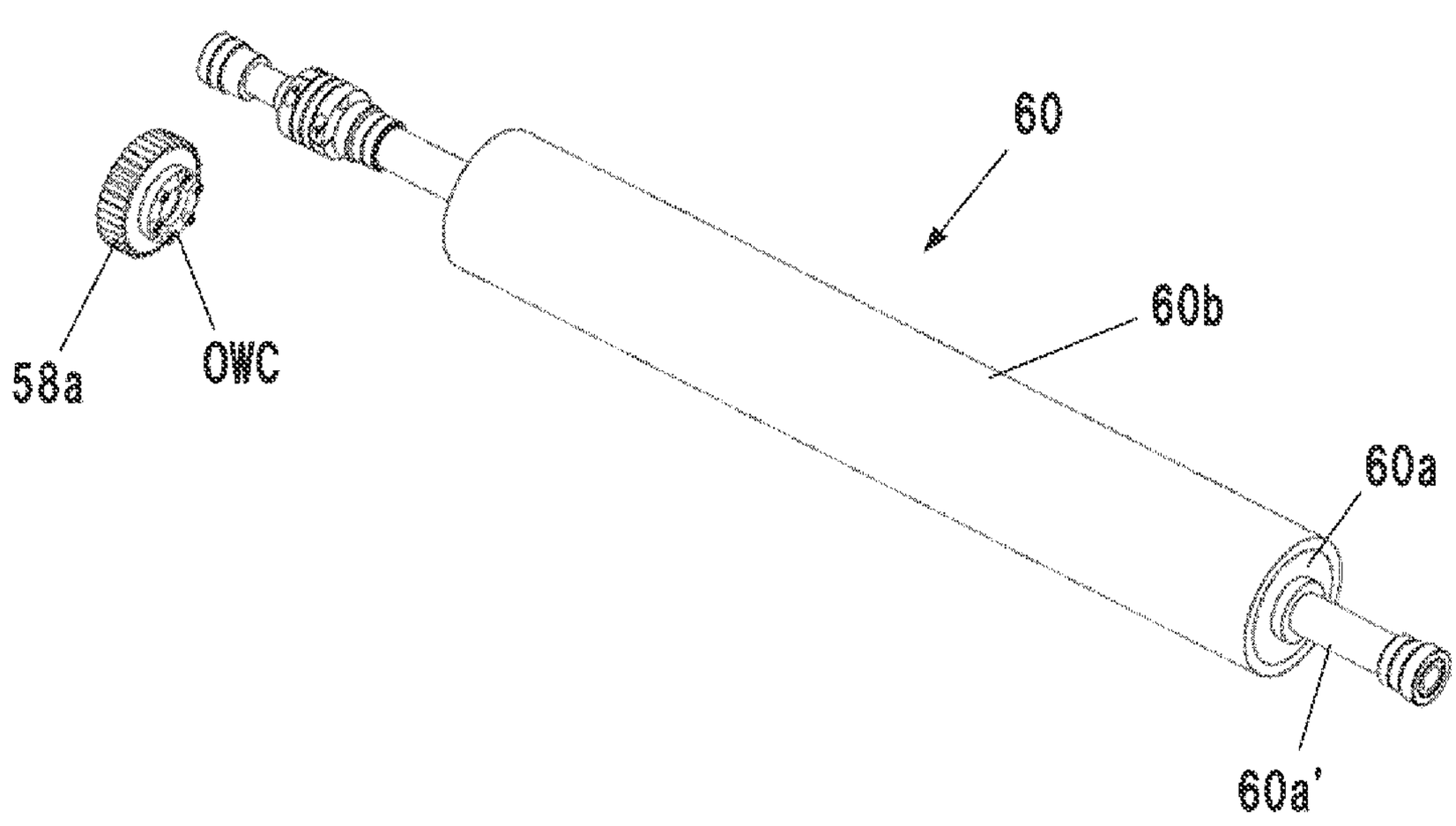
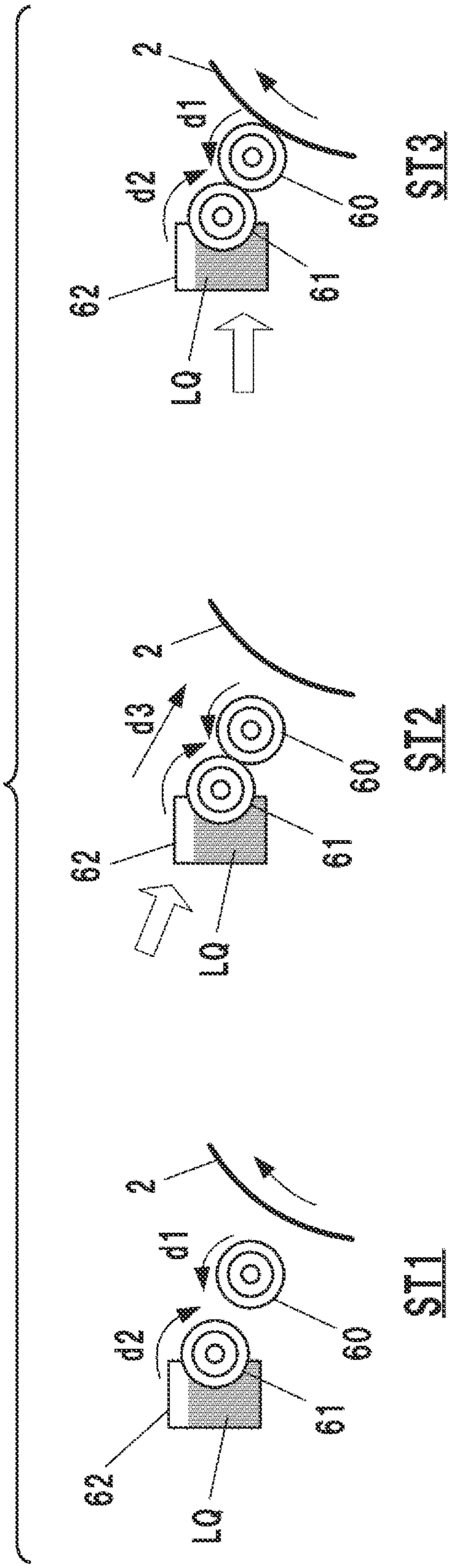


FIG. 13


2
d1
d2
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ST3
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61
LO
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d3
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ST2
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LO
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d1
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ST1
62
61
LO
2
41a
MR
d1
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ST5
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d2
61
LO
2
60
ST4
62
61
LO

FIG. 14A

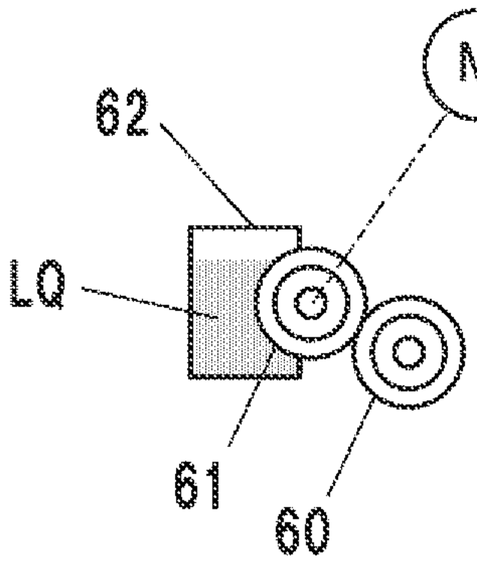


FIG. 14B

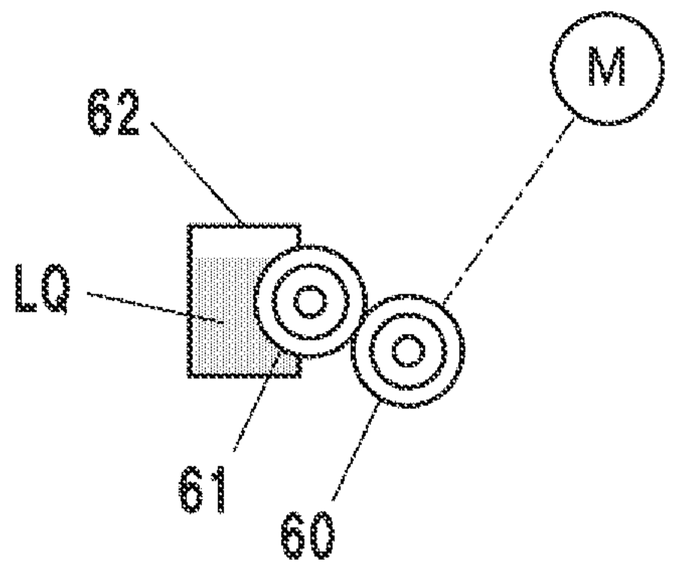
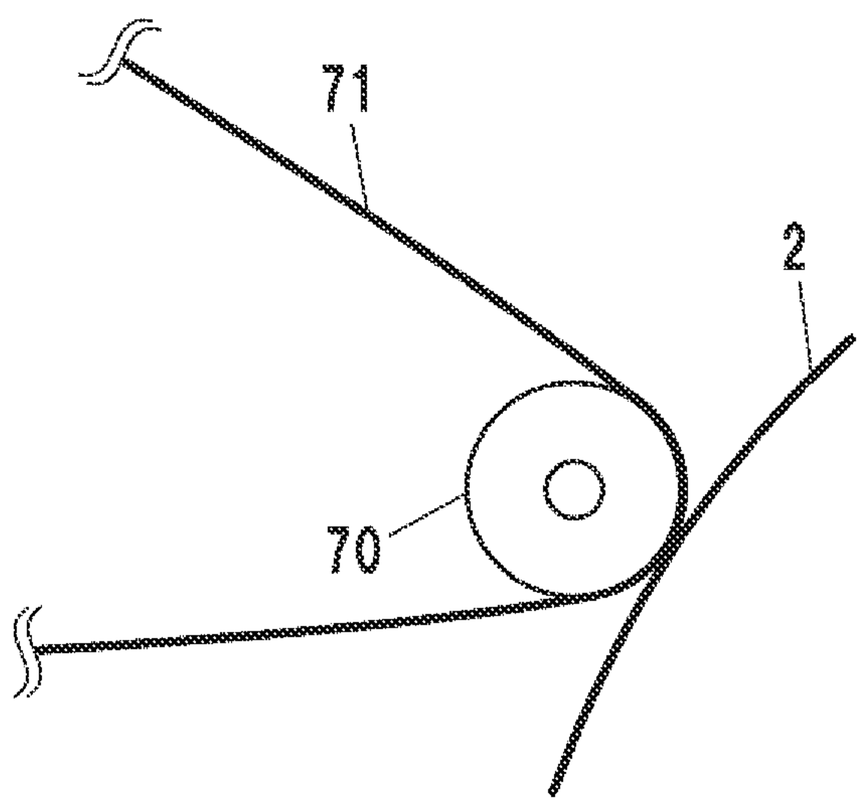


FIG. 14C



PRINTING APPARATUS AND CONTROL METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a transfer type printing technique.

Description of the Related Art

A technique of forming an ink image on a transfer member and transferring it to a print medium such as paper is proposed. For example, Japanese Patent Laid-Open No. 2003-182064 discloses an image forming apparatus configured to form an ink image on an intermediate member and transfer the ink image to a sheet. This apparatus includes an inkjet device that forms a primary image on the intermediate member. This apparatus also includes a zone where an aggregate is formed in the primary image, a zone where a liquid is partially removed from the aggregate, a zone where an image is transferred to a sheet, and a zone where the surface of the intermediate member is reproduced before a new primary image is formed. Japanese Patent Laid-Open No. 2014-18988 discloses an apparatus that applies a liquid onto paper on a drum using an application roller.

Similarly to the apparatus described in Japanese Patent Laid-Open No. 2003-182064, a processing apparatus that supplies a liquid onto a portion around a transfer member or removes a liquid from the portion includes, for example, a rotating member such as a roller pressed against the transfer member. In an arrangement in which a plurality of transfer members are supported, when a concave portion between the adjacent transfer members faces the rotating member, the rotating member is not temporarily pressed against the transfer member, and thus the rotation speed of the rotating member may decrease. This may wear the surfaces of the roller and transfer member when they are pressed again against each other. This may also change the moving speed of the transfer member.

SUMMARY OF THE INVENTION

The present invention provides a technique of reducing a decrease in speed of a rotating member when the rotating member passes between adjacent transfer members in an arrangement in which a plurality of transfer members are supported.

According to an aspect of the present invention, there is provided a printing apparatus comprising: a transfer drum configured to rotate while supporting a plurality of transfer members on each of which an image is formed by discharging ink from a printhead; a rotating member configured to apply a processing liquid while being pressed against each of the plurality of transfer members; a concave portion formed lower than a surface of each of the plurality of transfer members between the adjacent transfer members; and a driving unit configured to driven-rotate the rotating member in accordance with rotation of the transfer drum in a state in which the rotating member is pressed against the transfer member, and driving-rotate the rotating member in a state in which the rotating member faces the concave portion.

Further features of the present invention will become apparent from the following description of exemplary embodiments (with reference to the attached drawings).

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view showing a printing system;

FIG. **2** is a perspective view showing a print unit;

FIG. **3** is an explanatory view showing a displacement mode of the print unit in FIG. **2**;

FIG. **4** is a block diagram showing a control system of the printing system in FIG. **1**;

FIG. **5** is a block diagram showing the control system of the printing system in FIG. **1**;

FIG. **6** is an explanatory view showing an example of the operation of the printing system in FIG. **1**;

FIG. **7** is an explanatory view showing an example of the operation of the printing system in FIG. **1**;

FIGS. **8**A and **8**B are perspective views each showing an application unit;

FIG. **9** is a view showing an example of the arrangement of a transfer drum and transfer members;

FIG. **10**A is a perspective view showing the application unit;

FIG. **10**B is a perspective view showing the arrangement of part of the application unit;

FIG. **11** is a sectional view taken along a line I-I in FIG. **10**A and showing a portion around rollers;

FIGS. **12**A and **12**B are views for explaining the roller;

FIG. **13** is a view showing an example of the operation of the application unit; and

FIGS. **14**A to **14**C are views for respectively explaining other examples.

DESCRIPTION OF THE EMBODIMENTS

Embodiments of the present invention will be described with reference to the accompanying drawings. In each view, arrows X and Y indicate horizontal directions perpendicular to each other. An arrow Z indicates a vertical direction.

<Printing System>

FIG. **1** is a front view schematically showing a printing system (printing apparatus) **1** according to an embodiment of the present invention. The printing system **1** is a sheet inkjet printer that forms (manufactures) a printed product P' by transferring an ink image to a print medium P via a transfer member **2**. The printing system **1** includes a printing apparatus **1**A and a conveyance apparatus **1**B. In this embodiment, an X direction, a Y direction, and a Z direction indicate the widthwise direction (total length direction), the depth direction, and the height direction of the printing system **1**, respectively. The print medium P is conveyed in the X direction.

Note that "print" includes not only formation of significant information such as a character or graphic pattern but also formation of an image, design, or pattern on print media in a broader sense or processing of print media regardless of whether the information is significant or insignificant or has become obvious to allow human visual perception. In this embodiment, "print media" are assumed to be paper sheets but may be fabrics, plastic films, and the like.

An ink component is not particularly limited. In this embodiment, however, a case is assumed in which aqueous pigment ink that includes a pigment as a coloring material, water, and a resin is used.

<Printing Apparatus>

The printing apparatus **1**A includes a print unit **3**, a transfer unit **4**, peripheral units **5**A to **5**D, and a supply unit **6**.

<Print Unit>

The print unit **3** includes a plurality of printheads **30** and a carriage **31**. A description will be made with reference to FIGS. **1** and **2**. FIG. **2** is perspective view showing the print unit **3**. The printheads **30** discharge liquid ink to the transfer member **2** and form ink images of a printed image on the transfer member **2**.

In this embodiment, each printhead **30** is a full-line head elongated in the Y direction, and nozzles are arrayed in a range where they cover the width of an image printing area of a print medium having a usable maximum size. Each printhead **30** has an ink discharge surface with the opened nozzle on its lower surface, and the ink discharge surface faces the surface of the transfer member **2** via a minute gap (for example, several mm). In this embodiment, the transfer member **2** is configured to move on a circular orbit cyclically, and thus the plurality of printheads **30** are arranged radially.

Each nozzle includes a discharge element. The discharge element is, for example, an element that generates a pressure in the nozzle and discharges ink in the nozzle, and the technique of an inkjet head in a well-known inkjet printer is applicable. For example, an element that discharges ink by causing film boiling in ink with an electrothermal transducer and forming a bubble, an element that discharges ink by an electromechanical transducer (piezoelectric element), an element that discharges ink by using static electricity, or the like can be given as the discharge element. A discharge element that uses the electrothermal transducer can be used from the viewpoint of high-speed and high-density printing.

In this embodiment, nine printheads **30** are provided. The respective printheads **30** discharge different kinds of inks. The different kinds of inks are, for example, different in coloring material and include yellow ink, magenta ink, cyan ink, black ink, and the like. One printhead **30** discharges one kind of ink. However, one printhead **30** may be configured to discharge the plurality of kinds of inks. When the plurality of printheads **30** are thus provided, some of them may discharge ink (for example, clear ink) that does not include a coloring material.

The carriage **31** supports the plurality of printheads **30**. The end of each printhead **30** on the side of an ink discharge surface is fixed to the carriage **31**. This makes it possible to maintain a gap on the surface between the ink discharge surface and the transfer member **2** more precisely. The carriage **31** is configured to be displaceable while mounting the printheads **30** by the guide of each guide member RL. In this embodiment, the guide members RL are rail members elongated in the Y direction and provided as a pair separately in the X direction. A slide portion **32** is provided on each side of the carriage **31** in the X direction. The slide portions **32** engage with the guide members RL and slide along the guide members RL in the Y direction.

FIG. **3** is a view showing a displacement mode of the print unit **3** and schematically shows the right side surface of the printing system **1**. A recovery unit **12** is provided in the rear of the printing system **1**. The recovery unit **12** has a mechanism for recovering discharge performance of the printheads **30**. For example, a cap mechanism which caps the ink discharge surface of each printhead **30**, a wiper mechanism which wipes the ink discharge surface, and a suction mechanism which sucks ink in the printhead **30** by a negative pressure from the ink discharge surface can be used as such a mechanism.

The guide member RL is elongated over the recovery unit **12** from the side of the transfer member **2**. By the guide of the guide member RL, the print unit **3** is displaceable between a discharge position POS**1** at which the print unit **3** is indicated by a solid line and a recovery position POS**3** at which the print unit **3** is indicated by a broken line, and is moved by a driving mechanism (not shown).

The discharge position POS**1** is a position at which the print unit **3** discharges ink to the transfer member **2** and a position at which the ink discharge surface of each printhead **30** faces the surface of the transfer member **2**. The recovery position POS**3** is a position retracted from the discharge position POS**1** and a position at which the print unit **3** is positioned above the recovery unit **12**. The recovery unit **12** can perform recovery processing on the printheads **30** when the print unit **3** is positioned at the recovery position POS**3**. In this embodiment, the recovery unit **12** can also perform the recovery processing in the middle of movement before the print unit **3** reaches the recovery position POS**3**. There is a preliminary recovery position POS**2** between the discharge position POS**1** and the recovery position POS**3**. The recovery unit **12** can perform preliminary recovery processing on the printheads **30** at the preliminary recovery position POS**2** while the printheads **30** move from the discharge position POS**1** to the recovery position POS**3**.

<Transfer Unit>

The transfer unit **4** will be described with reference to FIG. **1**. The transfer unit **4** includes a transfer drum (transfer cylinder) **41** and a pressurizing drum **42**. Each of these drums is a rotating body that rotates about a rotation axis in the Y direction and has a columnar outer peripheral surface. In FIG. **1**, arrows shown in respective views of the transfer drum **41** and the pressurizing drum **42** indicate their rotation directions. The transfer drum **41** rotates clockwise, and the pressurizing drum **42** rotates counterclockwise.

The transfer drum **41** is a support member that supports the transfer member **2** on its outer peripheral surface. The transfer member **2** is provided on the outer peripheral surface of the transfer drum **41** continuously or intermittently in a circumferential direction. If the transfer member **2** is provided continuously, it is formed into an endless swath. If the transfer member **2** is provided intermittently, it is formed into swaths with ends divided into a plurality of segments. The respective segments can be arranged in an arc at an equal pitch on the outer peripheral surface of the transfer drum **41**.

The transfer member **2** moves cyclically on the circular orbit by rotating the transfer drum **41**. By the rotational phase of the transfer drum **41**, the position of the transfer member **2** can be discriminated into a processing area R**1** before discharge, a discharge area R**2**, processing areas R**3** and R**4** after discharge, a transfer area R**5**, and a processing area R**6** after transfer. The transfer member **2** passes through these areas cyclically.

The processing area R**1** before discharge is an area where preprocessing is performed on the transfer member **2** before the print unit **3** discharges ink and an area where the peripheral unit **5**A performs processing. In this embodiment, a reactive liquid is applied. The discharge area R**2** is a formation area where the print unit **3** forms an ink image by discharging ink to the transfer member **2**. The processing areas R**3** and R**4** after discharge are processing areas where processing is performed on the ink image after ink discharge. The processing area R**3** after discharge is an area where the peripheral unit **5**B performs processing, and the processing area R**4** after discharge is an area where the peripheral unit **5**C performs processing. The transfer area R**5** is an area where the transfer unit **4** transfers the ink image on the transfer member **2** to the print medium P. The processing area R**6** after transfer is an area where post

processing is performed on the transfer member **2** after transfer and an area where the peripheral unit **5**D performs processing.

In this embodiment, the discharge area R**2** is an area with a predetermined section. The other areas R**1** and R**3** to R**6** have narrower sections than the discharge area R**2**. Comparing to the face of a clock, in this embodiment, the processing area R**1** before discharge is positioned at almost 10 o'clock, the discharge area R**2** is in a range from almost 11 o'clock to 1 o'clock, the processing area R**3** after discharge is positioned at almost 2 o'clock, and the processing area R**4** after discharge is positioned at almost 4 o'clock. The transfer area R**5** is positioned at almost 6 o'clock, and the processing area R**6** after transfer is an area at almost 8 o'clock.

The transfer member **2** may be formed by a single layer but may be an accumulative body of a plurality of layers. If the transfer member **2** is formed by the plurality of layers, it may include three layers of, for example, a surface layer, an elastic layer, and a compressed layer. The surface layer is an outermost layer having an image formation surface where the ink image is formed. By providing the compressed layer, the compressed layer absorbs deformation and disperses a local pressure fluctuation, making it possible to maintain transferability even at the time of high-speed printing. The elastic layer is a layer between the surface layer and the compressed layer.

As a material for the surface layer, various materials, such as a resin and a ceramic, can be used appropriately. With respect to durability, or the like, however, a material high in compressive modulus can be used. More specifically, an acrylic resin, an acrylic silicone resin, a fluoride-containing resin, a condensate obtained by condensing a hydrolyzable organosilicon compound, and the like, can be used. The surface layer that has undergone a surface treatment may be used in order to improve wettability of the reactive liquid, the transferability of an image, or the like. Frame processing, a corona treatment, a plasma treatment, a polishing treatment, a roughing treatment, an active energy beam irradiation treatment, an ozone treatment, a surfactant treatment, a silane coupling treatment, or the like, can be used as the surface treatment. A plurality of these treatments may be combined. It is also possible to provide any desired surface shape in the surface layer.

For example, acrylonitrile-butadiene rubber, acrylic rubber, chloroprene rubber, urethane rubber, silicone rubber, or the like, can be used as a material for the compressed layer. When such a rubber material is formed, a porous rubber material may be formed by blending a predetermined amount of a vulcanizing agent, vulcanizing accelerator, or the like, and further blending a foaming agent, or a filling agent, such as hollow fine particles or salt, as needed. Consequently, a bubble portion is compressed along with a volume change with respect to various pressure fluctuations, and thus, deformation in directions other than a compression direction is small, making it possible to obtain more stable transferability and durability. As the porous rubber material, there are a material having an open cell structure in which respective pores continue to each other and a material having a closed cell structure in which the respective pores are independent of each other. However, either structure may be used, or both of these structures may be used.

As a member for the elastic layer, the various materials, such as the resin and the ceramic, can be used appropriately. With respect to processing characteristics, various materials of an elastomer material and a rubber material can be used. More specifically, for example, fluorosilicone rubber, phenyl silicone rubber, fluorine rubber, chloroprene rubber, urethane rubber, nitrile rubber, and the like, can be used. In addition, ethylene propylene rubber, natural rubber, styrene rubber, isoprene rubber, butadiene rubber, the copolymer of ethylene/propylene/butadiene, nitrile-butadiene rubber, and the like, can be used. In particular, silicone rubber, fluorosilicone rubber, and phenyl silicon rubber are advantageous in terms of dimensional stability and durability because of their small compression set. They are also advantageous in terms of transferability because of their small elasticity change by a temperature.

Between the surface layer and the elastic layer and between the elastic layer and the compressed layer, various adhesives or double-sided adhesive tapes can also be used in order to fix them to each other. The transfer member **2** may also include a reinforce layer high in compressive modulus in order to suppress elongation in a horizontal direction or maintain resilience when attached to the transfer drum **41**. Woven fabric may be used as a reinforce layer. The transfer member **2** can be manufactured by combining the respective layers formed by the materials described above in any desired manner.

The outer peripheral surface of the pressurizing drum **42** is pressed against the transfer member **2**. At least one grip mechanism which grips the leading edge portion of the print medium P is provided on the outer peripheral surface of the pressurizing drum **42**. A plurality of grip mechanisms may be provided separately in the circumferential direction of the pressurizing drum **42**. The ink image on the transfer member **2** is transferred to the print medium P when it passes through a nip portion between the pressurizing drum **42** and the transfer member **2** while being conveyed in tight contact with the outer peripheral surface of the pressurizing drum **42**.

The transfer drum **41** and the pressurizing drum **42** can share a driving source such as a motor that drives them, and a driving force can be delivered by a transmission mechanism such as a gear mechanism.

<Peripheral Unit>

The peripheral units **5**A to **5**D are arranged around the transfer drum **41**. In this embodiment, the peripheral units **5**A to **5**D are specifically an application unit, an absorption unit, a heating unit, and a cleaning unit in order.

The application unit **5**A is a mechanism which applies the reactive liquid onto the transfer member **2** before the print unit **3** discharges ink. The reactive liquid is a liquid that contains a component increasing an ink viscosity. An increase in ink viscosity here means that a coloring material, a resin, and the like that form the ink react chemically or suck physically by contacting the component that increases the ink viscosity, recognizing the increase in ink viscosity. This increase in ink viscosity includes not only a case in which an increase in viscosity of entire ink is recognized but also a case in which a local increase in viscosity is generated by coagulating some of components such as the coloring material and the resin that form the ink.

The component that increases the ink viscosity can use, without particular limitation, a substance, such as metal ions, or a polymeric coagulant that causes a pH change in ink and coagulates the coloring material in the ink, and can use an organic acid. For example, a roller, a printhead, a die coating apparatus (die coater), a blade coating apparatus (blade coater), or the like, can be used as a mechanism which applies the reactive liquid. If the reactive liquid is applied to the transfer member **2** before the ink is discharged to the transfer member **2**, it is possible to immediately fix ink that

reaches the transfer member **2**. This makes it possible to suppress bleeding caused by mixing adjacent inks.

The absorption unit **5**B is a mechanism which absorbs a liquid component from the ink image on the transfer member **2** before transfer. It is possible to suppress, for example, a blur of an image printed on the print medium P by decreasing the liquid component of the ink image. Describing a decrease in liquid component from another point of view, it is also possible to represent it as condensing ink that forms the ink image on the transfer member **2**. Condensing the ink means increasing the content of a solid content such as a coloring material or a resin included in the ink with respect to the liquid component by decreasing the liquid component included in the ink.

The absorption unit **5**B includes, for example, a liquid absorbing member that decreases the amount of the liquid component of the ink image by contacting the ink image. The liquid absorbing member may be formed on the outer peripheral surface of the roller or may be formed into an endless sheet-like shape and run cyclically. In terms of protection of the ink image, the liquid absorbing member may be moved in synchronism with the transfer member **2** by making the moving speed of the liquid absorbing member equal to the peripheral speed of the transfer member **2**.

The liquid absorbing member may include a porous body that contacts the ink image. The pore size of the porous body on the surface that contacts the ink image may be equal to or smaller than 10 μm in order to suppress adherence of an ink solid content to the liquid absorbing member. The pore size here refers to an average diameter and can be measured by a known means such as a mercury intrusion technique, a nitrogen adsorption method, an SEM image observation, or the like. Note that the liquid component does not have a fixed shape, and is not particularly limited if it has fluidity and an almost constant volume. For example, water, an organic solvent, or the like, contained in the ink or reactive liquid can be used as the liquid component.

The heating unit **5**C is a mechanism which heats the ink image on the transfer member **2** before transfer. A resin in the ink image melts by heating the ink image, improving transferability to the print medium P. A heating temperature can be equal to or higher than the minimum film forming temperature (MFT) of the resin. The MFT can be measured by each apparatus that complies with a generally known method such as JIS K 6828-2: 2003 or ISO 2115: 1996. From the viewpoint of transferability and image robustness, the ink image may be heated at a temperature higher than the MFT by 10° C. or higher, or may further be heated at a temperature higher than the MFT by 20° C. or higher. The heating unit **5**C can use a known heating device, for example, various lamps such as infrared rays, a warm air fan, or the like. An infrared heater can be used in terms of heating efficiency.

The cleaning unit **5**D is a mechanism which cleans the transfer member **2** after transfer. The cleaning unit **5**D removes ink remaining on the transfer member **2**, dust on the transfer member **2**, or the like. The cleaning unit **5**D can use a known method, for example, a method of bringing a porous member into contact with the transfer member **2**, a method of scraping the surface of the transfer member **2** with a brush, a method of scratching the surface of the transfer member **2** with a blade, or the like as needed. A known shape such as a roller shape or a web shape can be used for a cleaning member used for cleaning.

As described above, in this embodiment, the application unit **5**A, the absorption unit **5**B, the heating unit **5**C, and the cleaning unit **5**D are included as the peripheral units. However, cooling functions of the transfer member **2** may be applied, or cooling units may be added to these units. In this embodiment, the temperature of the transfer member **2** may be increased by heat of the heating unit **5**C. If the ink image exceeds the boiling point of water as a prime solvent of ink after the print unit **3** discharges ink to the transfer member **2**, performance of liquid component absorption by the absorption unit **5**B may be degraded. It is possible to maintain the performance of liquid component absorption by cooling the transfer member **2** such that the temperature of the discharged ink is maintained below the boiling point of water.

The cooling unit may be an air blowing mechanism which blows air to the transfer member **2**, or a mechanism which brings a member (for example, a roller) into contact with the transfer member **2** and cools this member by air-cooling or water-cooling. The cooling unit may be a mechanism which cools the cleaning member of the cleaning unit **5**D. A cooling timing may be a period before application of the reactive liquid after transfer.

<Supply Unit>

The supply unit **6** is a mechanism which supplies ink to each printhead **30** of the print unit **3**. The supply unit **6** may be provided on the rear side of the printing system **1**. The supply unit **6** includes a reservoir TK that reserves ink for each kind of ink. Each reservoir TK may be made of a main tank and a sub tank. Each reservoir TK and a corresponding one of the printheads **30** communicate with each other by a liquid passageway **6***a*, and ink is supplied from the reservoir TK to the printhead **30**. The liquid passageway **6***a* may circulate ink between the reservoirs TK and the printheads **30**. The supply unit **6** may include, for example, a pump that circulates ink. A deaerating mechanism which deaerates bubbles in ink may be provided in the middle of the liquid passageway **6***a* or in each reservoir TK. A valve that adjusts the fluid pressure of ink and an atmospheric pressure may be provided in the middle of the liquid passageway **6***a* or in each reservoir TK. The heights of each reservoir TK and each printhead **30** in the Z direction may be designed such that the liquid surface of ink in the reservoir TK is positioned lower than the ink discharge surface of the printhead **30**.

<Conveyance Apparatus>

The conveyance apparatus **1**B is an apparatus that feeds the print medium P to the transfer unit **4** and discharges, from the transfer unit **4**, the printed product P' to which the ink image was transferred. The conveyance apparatus **1**B includes a feeding unit **7**, a plurality of conveyance drums **8** and **8***a*, two sprockets **8***b*, a chain **8***c*, and a collection unit **8***d*. In FIG. **1**, an arrow inside a view of each constituent element in the conveyance apparatus **1**B indicates a rotation direction of the constituent element, and an arrow outside the view of each constituent element indicates a conveyance path of the print medium P or the printed product P'. The print medium P is conveyed from the feeding unit **7** to the transfer unit **4**, and the printed product P' is conveyed from the transfer unit **4** to the collection unit **8***d*. The side of the feeding unit **7** may be referred to as an upstream side in a conveyance direction, and the side of the collection unit **8***d* may be referred to as a downstream side.

The feeding unit **7** includes a stacking unit where the plurality of print media P are stacked and a feeding mechanism which feeds the print media P one by one from the stacking unit to the most upstream conveyance drum **8**. Each of the conveyance drums **8** and **8***a* is a rotating body that rotates about the rotation axis in the Y direction and has a columnar outer peripheral surface. At least one grip mechanism which grips the leading edge portion of the print

medium P (printed product P') is provided on the outer peripheral surface of each of the conveyance drums **8** and **8***a*. A gripping operation and release operation of each grip mechanism may be controlled such that the print medium P is transferred between the adjacent conveyance drums.

The two conveyance drums **8***a* are used to reverse the print medium P. When the print medium P undergoes double-side printing, it is not transferred to the conveyance drum **8** adjacent on the downstream side but transferred to the conveyance drums **8***a* from the pressurizing drum **42** after transfer onto the surface. The print medium P is reversed via the two conveyance drums **8***a* and transferred to the pressurizing drum **42** again via the conveyance drums **8** on the upstream side of the pressurizing drum **42**. Consequently, the reverse surface of the print medium P faces the transfer drum **41**, transferring the ink image to the reverse surface.

The chain **8***c* is wound between the two sprockets **8***b*. One of the two sprockets **8***b* is a driving sprocket, and the other is a driven sprocket. The chain **8***c* runs cyclically by rotating the driving sprocket. The chain **8***c* includes a plurality of grip mechanisms spaced apart from each other in its longitudinal direction. Each grip mechanism grips the end of the printed product P'. The printed product P' is transferred from the conveyance drum **8** positioned at a downstream end to each grip mechanism of the chain **8***c*, and the printed product P' gripped by the grip mechanism is conveyed to the collection unit **8***d* by running the chain **8***c*, releasing gripping. Consequently, the printed product P' is stacked in the collection unit **8***d*.

<Post Processing Unit>

The conveyance apparatus **1**B includes post processing units **10**A and **10**B. The post processing units **10**A and **10**B are mechanisms which are arranged on the downstream side of the transfer unit **4**, and perform post processing on the printed product P'. The post processing unit **10**A performs processing on the obverse surface of the printed product P', and the post processing unit **10**B performs processing on the reverse surface of the printed product P'. The contents of the post processing include, for example, coating that aims at protection, improving the glossiness, and the like, of an image on the image printed surface of the printed product P'. For example, liquid application, sheet welding, lamination, and the like, can be used as an example of coating.

<Inspection Unit>

The conveyance apparatus **1**B includes inspection units **9**A and **9**B. The inspection units **9**A and **9**B are mechanisms which are arranged on the downstream side of the transfer unit **4**, and inspect the printed product P'.

In this embodiment, the inspection unit **9**A is an image capturing apparatus that captures an image printed on the printed product P' and includes an image sensor, for example, a CCD sensor, a CMOS sensor, or the like. The inspection unit **9**A captures a printed image while a printing operation is performed continuously. Based on the image captured by the inspection unit **9**A, it is possible to confirm a temporal change in tint or the like of the printed image and determine whether to correct image data or print data. In this embodiment, the inspection unit **9**A has an imaging range set on the outer peripheral surface of the pressurizing drum **42** and is arranged to be able to partially capture the printed image immediately after transfer. The inspection unit **9**A may inspect all printed images or may inspect the images every predetermined sheets.

In this embodiment, the inspection unit **9**B is also an image capturing apparatus that captures an image printed on the printed product P' and includes an image sensor, for example, a CCD sensor, a CMOS sensor, or the like. The inspection unit **9**B captures a printed image in a test printing operation. The inspection unit **9**B can capture the entire printed image. Based on the image captured by the inspection unit **9**B, it is possible to perform basic settings for various correction operations regarding print data. In this embodiment, the inspection unit **9**B is arranged at a position to capture the printed product P' conveyed by the chain **8***c*. When the inspection unit **9**B captures the printed image, it captures the entire image by temporarily suspending the run of the chain **8***c*. The inspection unit **9**B may be a scanner that scans the printed product P'.

<Control Unit>

A control unit of the printing system **1** will be described next. FIGS. **4** and **5** are block diagrams each showing a control unit **13** of the printing system **1**. The control unit **13** is communicably connected to a higher level apparatus (DFE) HC**2**, and the higher level apparatus HC**2** is communicably connected to a host apparatus HC**1**.

Original data to be the source of a printed image is generated or saved in the host apparatus HC**1**. The original data here is generated in the format of, for example, an electronic file such as a document file or an image file. This original data is transmitted to the higher level apparatus HC**2**. In the higher level apparatus HC**2**, the received original data is converted into a data format (for example, RGB data that represents an image by RGB) available by the control unit **13**. The converted data is transmitted from the higher level apparatus HC**2** to the control unit **13** as image data. The control unit **13** starts a printing operation based on the received image data.

In this embodiment, the control unit **13** is roughly divided into a main controller **13**A and an engine controller **13**B. The main controller **13**A includes a processing unit **131**, a storage unit **132**, an operation unit **133**, an image processing unit **134**, a communication I/F (interface) **135**, a buffer **136**, and a communication I/F **137**.

The processing unit **131** is a processor such as a CPU, executes programs stored in the storage unit **132**, and controls the entire main controller **13**A. The storage unit **132** is a storage device such as a RAM, a ROM, a hard disk, or an SSD, stores data and the programs executed by the processing unit (CPU) **131**, and provides the processing unit (CPU) **131** with a work area. The operation unit **133** is, for example, an input device such as a touch panel, a keyboard, or a mouse and accepts a user instruction.

The image processing unit **134** is, for example, an electronic circuit including an image processing processor. The buffer **136** is, for example, a RAM, a hard disk, or an SSD. The communication I/F **135** communicates with the higher level apparatus HC**2**, and the communication I/F **137** communicates with the engine controller **13**B. In FIG. **4**, broken-line arrows exemplify the processing sequence of image data. Image data received from the higher level apparatus HC**2** via the communication I/F **135** is accumulated in the buffer **136**. The image processing unit **134** reads out the image data from the buffer **136**, performs predetermined image processing on the readout image data, and stores the processed data in the buffer **136** again. The image data after the image processing stored in the buffer **136** is transmitted from the communication I/F **137** to the engine controller **13**B as print data used by a print engine.

As shown in FIG. **5**, the engine controller **13**B includes control units **14** and **15**A to **15**E, and obtains a detection result of a sensor group/actuator group **16** of the printing system **1** and controls driving of the groups. Each of these control units includes a processor such as a CPU, a storage

device such as a RAM or a ROM, and an interface with an external device. Note that the division of the control units is merely illustrative, and a plurality of subdivided control units may perform some of control operations or conversely, the plurality of control units may be integrated with each other, and one control unit may be configured to implement their control contents.

The engine control unit **14** controls the entire engine controller **13**B. The printing control unit **15**A converts print data received from the main controller **13**A into raster data or the like in a data format suitable for driving of the printheads **30**. The printing control unit **15**A controls discharge of each printhead **30**.

The transfer control unit **15**B controls the application unit **5**A, the absorption unit **5**B, the heating unit **5**C, and the cleaning unit **5**D.

The reliability control unit **15**C controls the supply unit **6**, the recovery unit **12**, and a driving mechanism which moves the print unit **3** between the discharge position POS**1** and the recovery position POS**3**.

The conveyance control unit **15**D controls driving of the transfer unit **4** and controls the conveyance apparatus **1**B. The inspection control unit **15**E controls the inspection unit **9**B and the inspection unit **9**A.

Of the sensor group/actuator group **16**, the sensor group includes a sensor that detects the position and speed of a movable part, a sensor that detects a temperature, an image sensor, and the like. The actuator group includes a motor, an electromagnetic solenoid, an electromagnetic valve, and the like.

Operation Example

FIG. **6** is a view schematically showing an example of a printing operation. Respective steps below are performed cyclically while rotating the transfer drum **41** and the pressurizing drum **42**. As shown in a state ST**1**, first, a reactive liquid L is applied from the application unit **5**A onto the transfer member **2**. A portion to which the reactive liquid L on the transfer member **2** is applied moves along with the rotation of the transfer drum **41**. When the portion to which the reactive liquid L is applied reaches under the printhead **30**, ink is discharged from the printhead **30** to the transfer member **2** as shown in a state ST**2**. Consequently, an ink image IM is formed. At this time, the discharged ink mixes with the reactive liquid L on the transfer member **2**, promoting coagulation of the coloring materials. The discharged ink is supplied from the reservoir TK of the supply unit **6** to the printhead **30**.

The ink image IM on the transfer member **2** moves along with the rotation of the transfer member **2**. When the ink image IM reaches the absorption unit **5**B, as shown in a state ST**3**, the absorption unit **5**B absorbs a liquid component from the ink image IM. When the ink image IM reaches the heating unit **5**C, as shown in a state ST**4**, the heating unit **5**C heats the ink image IM, a resin in the ink image IM melts, and a film of the ink image IM is formed. In synchronism with such formation of the ink image IM, the conveyance apparatus **1**B conveys the print medium P.

As shown in a state ST**5**, the ink image IM and the print medium P reach the nip portion between the transfer member **2** and the pressurizing drum **42**, the ink image IM is transferred to the print medium P, and the printed product P' is formed. Passing through the nip portion, the inspection unit **9**A captures an image printed on the printed product P' and inspects the printed image. The conveyance apparatus **1**B conveys the printed product P' to the collection unit **8***d*.

When a portion where the ink image IM on the transfer member **2** is formed reaches the cleaning unit **5**D, it is cleaned by the cleaning unit **5**D as shown in a state ST**6**. After the cleaning, the transfer member **2** rotates once, and transfer of the ink image to the print medium P is performed repeatedly in the same procedure. The description above has been given such that transfer of the ink image IM to one print medium P is performed once in one rotation of the transfer member **2** for the sake of easy understanding. It is possible, however, to continuously perform transfer of the ink image IM to the plurality of print media P in one rotation of the transfer member **2**.

Each printhead **30** needs maintenance if such a printing operation continues. FIG. **7** shows an operation example at the time of maintenance of each printhead **30**. A state ST**11** shows a state in which the print unit **3** is positioned at the discharge position POS**1**. A state ST**12** shows a state in which the print unit **3** passes through the preliminary recovery position POS**2**. Under passage, the recovery unit **12** performs a process of recovering discharge performance of each printhead **30** of the print unit **3**. Subsequently, as shown in a state ST**13**, the recovery unit **12** performs the process of recovering the discharge performance of each printhead **30** in a state in which the print unit **3** is positioned at the recovery position POS**3**.

<Application Unit>

An example of the arrangement of the application unit **5**A, transfer drum **41**, and transfer members **2** will be described with reference to FIGS. **8**A to **12**. The arrangement of the transfer drum **41** and transfer members **2** will be explained first with reference to FIGS. **8**A, **8**B, and **9**.

The transfer drum **41** shown in FIG. **9** and the like includes a cylindrical outer peripheral portion, and concave portions **41***a* are formed at an equal angular pitch (90°-pitch in the example of FIG. **9**) around a rotating shaft **41***b*. Each concave portion **41***a* is a space where a gripper that grips the end of the transfer member **2** is arranged. In the example of FIG. **9** and the like, four transfer members **2** (in other words, four segments) are held on the outer peripheral portion of the transfer drum **41** intermittently in a circumferential direction. In this arrangement, the ink image IM is formed on each of the surfaces of the four transfer members **2**. Each of the transfer members **2** corresponds to one print medium P. In other words, an arrangement capable of transferring the ink images IM to a maximum of four print media P in one rotation of the transfer drum **41** is adopted.

Concave portions (gaps) NR are formed between the adjacent transfer members. The concave portions NR are regions on the concave portions **41***a*. By rotating the transfer drum **41**, the transfer members **2** and the concave portions NR are cyclically moved to a region facing the application unit **5**A in the order of the transfer member **2**, the concave portion NR, the transfer member, the concave portion NR . . . .

The application unit **5**A will be described next with reference to FIGS. **8**A to **12**. The application unit **5**A is a liquid application apparatus capable of applying a liquid (reactive liquid) onto each transfer member **2** by a processing roller **60** before the formation of the ink image IM by the print unit **3**.

The application unit **5**A includes a plate-like base portion **50**. A movement guide unit **51** is provided on the base portion **50**. The movement guide unit **51** includes a pair of rails **501** and a plurality of sliders **502** provided on each rail **501**. Each rail **501** is elongated in the X direction, and the pair of rails **501** are separated from each other in the Y direction. Each slider **502** is provided to be slidable on the

corresponding rail **501**. In this embodiment, two sliders **502** are provided on each rail **501**, and thus four sliders **502** in total are provided.

A restriction unit **52** is provided on each rail **501**. The restriction unit **52** is an electric or fluid actuator (guide brake) that can slide on the rail **501**, similarly to the slider **502**, while releasably fixing its position at an arbitrary position on the rail **501**. The restriction unit **52** is arranged between the two sliders **502**. A support unit **53** is supported on the four sliders **502** and the two restriction units **52**. This allows the support unit **53** to move in the X direction. By setting the restriction units **52** in a restriction state (position fixed state), interference with the restriction units **52** restricts the movement of the support unit **53** in the X direction.

An actuator **54** that moves the support unit **53** is provided on the base portion **50**. In this embodiment, two actuators **54** are provided apart from each other in the Y direction. Each actuator **54** is implemented by, for example, an electric or fluid cylinder, and the extending/contracting direction of a rod is a direction (the X direction in this example) in which the processing roller **60** moves close to/away from the surface of the transfer member **2**. The ends of the rods of the actuators **54** are connected to the rear end of the support unit **53**, and the actuators **54** are driven to move the support unit **53** back and forth in the X direction. Note that each actuator **54** may be an elastic member such as a spring that biases the support unit **53** toward the transfer drum **41**.

The processing roller **60** and the driving unit of the processing roller **60** are supported by the support unit **53**. The processing roller **60** is elongated in the Y direction, and is rotatably supported by the support unit **53**. The processing roller **60** includes a columnar rotating member **60***a* with a rotating shaft **60***a*', and a processing medium **60***b* covering the outer peripheral portion of the rotating member **60***a*. The processing medium **60***b* is a cylindrical member made of, for example, a rubber material, and forms the obverse layer of the processing roller **60**. The processing medium **60***b* is pressed against the surface of the transfer member **2**, and applies the reactive liquid onto the surface of the transfer member **2**. The processing roller **60** functions as the application roller of the reactive liquid.

The driving unit includes a driving source M**1** and a transmission mechanism **58**. In this embodiment, the driving source M**1** is a motor such as a stepping motor. The transmission mechanism **58** transmits the driving force of the driving source M**1** to the processing roller **60**. In this embodiment, the transmission mechanism **58** is a gear apparatus, and includes a gear **58***a* that meshes with a gear provided in the output shaft of the driving source M**1**. FIGS. **12**A and **12**B respectively show the processing roller **60** in which the gear **58***a* is mounted and the processing roller **60** from which the gear **58***a* is detached. The gear **58***a* is provided with a one-way clutch OWC. The one-way clutch OWC transmits the rotation of the driving source M**1** to the processing roller **60** with respect to only rotation in one direction (a d**1** direction in FIG. **11** and the like).

Furthermore, a support unit **55** is supported by the support unit **53** via a movement guide unit **56**. The movement guide unit **56** has the same arrangement as that of the movement guide unit **51**, and is formed from rails and sliders slidable on the rails. The support unit **55** is supported on the sliders of the movement guide unit **56**. In the movement guide unit **56**, two sets of rails and sliders are provided apart from each other in the Y direction. The rails are elongated in the X direction and a direction (a d**3** direction in FIG. **10**A and the like) inclined in the Z direction.

An actuator **57** that moves on the support unit **55** is provided on the support unit **53**. In this embodiment, two actuators **57** are provided apart from each other in the Y direction. Each actuator **57** is implemented by, for example, an electric or fluid cylinder, and the extending/contracting direction of a rod is a direction (the d**3** direction in this example) in which a supply roller **61** moves close to/away from the surface of the processing roller **60**. The ends of the rods of the actuators **57** are connected to the rear end of the support unit **55**, and the actuators **57** are driven to move the support unit **55** back and forth in the d**3** direction. Note that each actuator **57** may be an elastic member such as a spring that biases the support unit **55** toward the processing roller **60**.

The supply roller **61** and the driving unit are supported by the support unit **55**. The supply roller **61** is elongated in the Y direction, and is rotatably supported by the support unit **55**. The supply roller **61** includes a columnar rotating member **61***a* with a rotating shaft **61***a*', and a supply medium **61***b* covering the outer peripheral portion of the rotating member **61***a*. The supply medium **61***b* is a cylindrical member made of, for example, a ceramic material and having an obverse layer on which a number of fine cells are formed, and forms the obverse layer of the supply roller **61**. The supply medium **61***b* is pressed against the surface of the processing medium **60***b* of the processing roller **60**, and supplies the reactive liquid to the processing roller **60**.

The driving unit is a unit that rotates the supply roller **61** and also rotates the processing roller **60** via the supply roller **61**. The processing unit includes a driving source M**2** and a transmission mechanism **59**. In this embodiment, the driving source M**2** is a motor such as a stepping motor. The transmission mechanism **59** transmits the driving force of the driving source M**2** to the roller **61**. In this embodiment, the transmission mechanism **59** is a gear apparatus, and includes a gear **59***a* that meshes with a gear provided in the output shaft of the driving source M**2**. Similarly to the gear **58***a* described with reference to FIGS. **12**A and **12**B, the gear **59***a* is also provided with a one-way clutch OWC (not shown), and transmits the rotation of the driving source M**2** to the roller **61** with respect to only rotation in one direction (a d**2** direction in FIG. **11** and the like).

FIG. **11** is a sectional view taken along a line I-I in FIG. **10**A and showing a portion around the processing roller **60** and the supply roller **61**. A reservoir unit **62** that reserves a reactive liquid LQ is supported by the support unit **55**. The reservoir unit **62** includes a reservoir tank (doctor chamber) **62***a* and blades (doctor blades) **62***b*. The reservoir tank **62***a* forms a reservoir space extending in parallel to the longitudinal direction of the supply roller **61**, and reserves the reactive liquid LQ in this space. A portion of the supply medium **61***b* of the supply roller **61** is dipped in the reactive liquid LQ in the reservoir tank **62***a*, and the reactive liquid LQ adheres to the surface of the supply medium **61***b* by the rotation of the supply roller **61**. Two sets of blades **62***b* are provided apart from each other in the Z direction. Each blade **62***b* extends in parallel to the longitudinal direction of the supply roller **61**. The blades **62***b* scrape the extra reactive liquid LQ adhering to the supply roller **61** or the reactive liquid LQ remaining on the supply roller **61**.

In the application unit **5**A having the above arrangement, the supply roller **61**, the driving unit (M**2**, **59**), and the reservoir unit **62** are supported by the support unit **55**. If the actuators **57** are driven to move the support unit **55**, the overall unit moves close to/away from the processing roller **60**. The support unit **55**, the processing roller **60**, and the driving unit (M**1**, **58**) are supported by the support unit **53**.

If the actuators **54** are driven to move the support unit **53**, the overall unit moves close to/away from the transfer member **2**.

Operation Example

An example of the operation of the application unit **5**A will be described with reference to FIG. **13**. The application unit **5**A operates under the control of the transfer control unit **15**B. States ST**1** to ST**3** in FIG. **13** show a preparation operation before the start of a printing operation, and states ST**4** and ST**5** show an operation after the end of the preparation operation. During the printing operation, the application unit **5**A is in the state ST**4** or ST**5**.

In a warm-up stage at the start of a system, as shown in the state ST**1**, the processing roller **60** is arranged at a position separated from the transfer member **2**, and the supply roller **61** is arranged at a position separated from the processing roller **60**. These arrangements are adjusted by the actuators **54** and **57**.

The motors M**1** and M**2** and the transfer drum **41** start rotating. The peripheral speeds of the processing roller **60**, the supply roller **61**, and the surface of the transfer member **2** will now be described. Let V**2** be the peripheral speed of the surface of the transfer member **2**, V**60** be the peripheral speed of the processing roller **60**, and V**61** be the peripheral speed of the supply roller **61**. Although the three peripheral speeds are approximated to each other, the rotation speeds of the rollers **60** and **61** and the transfer drum **41** are controlled to satisfy V**2**>V**61**>V**60**.

Running-in of the supply roller **61** is performed by rotating the supply roller **61**, and then the reactive liquid LQ adheres to the surface of the supply roller **61**. Next, the actuators **57** are driven to move the support unit **55** in the d**3** direction, thereby pressing the supply roller **61** against the processing roller **60**, as shown in the state ST**2**. The peripheral speeds of the processing roller **60** and the supply roller **61** have a relationship of V**61**>V**60**. Since the peripheral speed of the supply roller **61** is slightly higher, a one-way clutch **58***a'* has no effect, and the processing roller **60** rotates together with the supply roller **61**. This performs running-in of the processing roller **60** and the supply roller **61**. Although the processing roller **60** rotates together with the supply roller **61**, the motor M**1** rotates the processing roller **60**, thereby reducing the load of the motor M**2**.

Next, the actuators **54** are driven to move the support unit **53** in the X direction, thereby pressing the processing roller **60** against the transfer member **2**, as shown in the state ST**3**. After pressing, the restriction unit **52** is operated to fix the position of the support unit **53**. This fixes the position of the processing roller **60** while maintaining the state in which the processing roller **60** is pressed against the transfer member **2**. Even during the printing operation, driving of the motors M**1** and M**2** is continued.

Since the peripheral speeds of the processing roller **60**, supply roller **61**, and transfer member **2** have the relationship of V**2**>V**61**>V**60**, the processing roller **60** rotates together with the transfer member **2** and the supply roller **61** rotates together with the processing roller **60** in a section where the processing roller **60** faces the transfer member **2**, as shown in the state ST**4**. The one-way clutch OWC has no effect and the one-way clutch OWC of the supply roller **61** has no effect either. Although the processing roller **60** rotates together with the transfer member **2** directly, the motor M**1** rotates the processing roller **60** to reduce the load of the driving source that rotates the transfer drum **41**. Although the supply roller **61** rotates together with the transfer member **2** via the processing roller **60**, the motor M**2** rotates the supply roller **61** to reduce the load of the driving source that rotates the transfer drum **41**.

In a section where the processing roller **60** does not face the transfer member **2** and passes through the concave portion NR, as shown in the state ST**5**, the pressure-contact between the processing roller **60** and the transfer member **2** is temporarily released. However, the position of the processing roller **60** is fixed by the restriction unit **52**. In other words, the center distance between the processing roller **60** and the transfer drum **41** is maintained constant. Therefore, the processing roller **60** does not move in a direction to enter the concave portion NR (or concave portion **41***a*). In an arrangement in which the processing roller **60** is simply biased against the transfer member **2**, every time the processing roller **60** passes through the concave portion NR, the processing roller **60** may enter the concave portion NR. This may damage the processing roller **60** and the transfer member **2** or generate a strange sound. In this embodiment, however, since the center distance between the processing roller **60** and the transfer drum **41** is maintained constant, the processing roller **60** does not move to the concave portion NR.

Since the processing roller **60** is not pressed against the transfer member **2** in a section where the processing roller **60** passes through the concave portion NR, the processing roller **60** does not rotate together with the transfer member **2**. If the peripheral speed of the processing roller **60** greatly decreases, when the processing roller **60** passes through the concave portion NR and is pressed against the transfer member **2** again, the friction between the processing roller **60** and the transfer member **2** may become large. This may wear the surfaces of the processing roller **60** and transfer member **2**. In addition, this may change the speed of the transfer drum **41** although the transfer drum **41** basically rotates at a constant speed.

In this embodiment, in a state in which the processing roller **60** is not pressed against the transfer member **2**, the driving force of the motor M**2** rotates the supply roller **61**, and the processing roller **60** rotates together with the supply roller **61**. That is, in terms of the relationship between the processing roller **60** and the transfer member **2**, the processing roller **60** is not driven-rotated in accordance with the transfer member **2**, but is driving-rotated by the driving force of the motor M**2** in the section where the processing roller **60** passes through the concave portion NR. Since the peripheral speed of the processing roller **60** does not greatly decrease, when the processing roller **60** passes through the concave portion NR and is pressed against the transfer member **2** again, the friction between the processing roller **60** and the transfer member **2** can be made small. By rotating the processing roller **60** by the motor M**1** even in the section where the processing roller **60** passes through the concave portion NR, the load of the motor M**2** is reduced. Furthermore, it is possible to reduce damage to the transfer member, and improve the application accuracy of the processing liquid onto the transfer member. This improves the quality of an image formed on the transfer member.

As described above, according to this embodiment, in the arrangement in which the plurality of transfer members **2** are supported in the circumferential direction, it is possible to reduce damage to the transfer member **2** caused by the processing roller **60** and generation of a strange sound.

<Other Examples of Arrangement of Application Unit>

In the above-described example of the application unit **5**A, the restriction unit **52** restricts the movement of the support unit **53** in both X directions but may restrict the

movement of the support unit **53** in only one direction. That is, it is only necessary to restrict the movement of the processing roller **60** in a direction to enter the concave portion NR.

In the above-described example of the application unit **5**A, the two driving sources (motors M**1** and M**2**) are provided. However, one driving source may be provided. FIG. **14**A is a schematic view showing an example. The example of FIG. **14**A shows an arrangement in which the supply roller **61** is driven by a motor M. The motor M**2** and the transmission mechanism **59** in the above-described example are kept intact, the motor M**1** and transmission mechanism **58** of the processing roller **60** are eliminated, and the processing roller **60** is supported to be freely rotatable. The peripheral speeds of the supply roller **61** and transfer member **2** are set to have a relationship of V**2**>V**61**. In a state in which the processing roller **60** is pressed against the transfer member **2**, the processing roller **60** rotates together with the transfer member **2**. In a section where the processing roller **60** passes through the concave portion NR, the processing roller **60** rotates together with the supply roller **61**.

FIG. **14**B is a schematic view showing another example. The other example of FIG. **14**B shows an arrangement in which the processing roller **60** is driven by the motor M. The motor M**1** and the transmission mechanism **58** in the above-described example are kept intact, and the motor M**2** and transmission mechanism **59** of the supply roller **61** are eliminated. The supply roller **61** is supported to be freely rotatable. The peripheral speeds of the processing roller **60** and transfer member **2** are set to have a relationship of V**2**>V**60**. Unlike the state ST**1** of FIG. **13**, it is unnecessary to separate the processing roller **60** and the supply roller **61** from each other. The supply roller **61** is always pressed against the processing roller **60** to rotate together with the processing roller **60**.

In the above-described example of the application unit **5**A, the driving method of the processing roller **60** is automatically switched by the one-way clutch OWC and the peripheral speeds of the rollers **60** and **61** and transfer member **2** in accordance with whether the section is that where the processing roller **60** passes through the concave portion NR. However, the driving method can be switched by electronic control. For example, the rotational phase of the transfer member **2** is detected by a sensor. In a phase in which the processing roller **60** passes through the concave portion NR, the driving source such as a motor drives the processing roller **60**. On the other hand, in a phase in which the processing roller **60** is pressed against the transfer member **2**, the driving force acting on the processing roller **60** is cut off and is driven-rotated in accordance with the transfer member **2**.

In the above-described example of the application unit **5**A, the arrangement in which the processing roller **60** is pressed against the transfer member **2** is adopted. However, an arrangement in which an endless belt as a processing medium is pressed against the transfer member **2** may be adopted. FIG. **14**C shows an example. A processing medium **71** as an endless belt is wound around a rotating member **70** such as a pulley, and pressed against the transfer member **2**. In this arrangement as well, by setting a constant center distance between the rotating member **70** and the transfer drum **41**, it is possible to avoid the rotating member **70** from falling into the concave portion NR. While the processing medium **71** is pressed against the transfer member **2**, the processing medium **71** is made to travel in accordance with the transfer member **2**. In a section where the rotating member **70** passes through the concave portion NR, the processing medium **71** is driven to travel by the driving force of a driving source such as a motor.

The arrangement of the above-described application unit **5**A is not limited to application of the reactive liquid, and is applicable to various processes for the surface of the transfer member **2**. For example, the arrangement is applicable to absorption of the liquid by the absorption unit **5**B, cleaning of the surface of the transfer member **2** by the cleaning unit **5**D, and the like.

Other Embodiments

In the above embodiment, the print unit **3** includes the plurality of printheads **30**. However, a print unit **3** may include one printhead **30**. The printhead **30** may not be a full-line head but may be of a serial type that forms an ink image while scanning the printhead **30** in a Y direction.

A conveyance mechanism of the print medium P may adopt another method such as a method of clipping and conveying the print medium P by the pair of rollers. In the method of conveying the print medium P by the pair of rollers or the like, a roll sheet may be used as the print medium P, and a printed product P' may be formed by cutting the roll sheet after transfer.

Embodiment(s) of the present invention can also be realized by a computer of a system or apparatus that reads out and executes computer executable instructions (e.g., one or more programs) recorded on a storage medium (which may also be referred to more fully as a 'non-transitory computer-readable storage medium') to perform the functions of one or more of the above-described embodiment(s) and/or that includes one or more circuits (e.g., application specific integrated circuit (ASIC)) for performing the functions of one or more of the above-described embodiment(s), and by a method performed by the computer of the system or apparatus by, for example, reading out and executing the computer executable instructions from the storage medium to perform the functions of one or more of the above-described embodiment(s) and/or controlling the one or more circuits to perform the functions of one or more of the above-described embodiment(s). The computer may comprise one or more processors (e.g., central processing unit (CPU), micro processing unit (MPU)) and may include a network of separate computers or separate processors to read out and execute the computer executable instructions. The computer executable instructions may be provided to the computer, for example, from a network or the storage medium. The storage medium may include, for example, one or more of a hard disk, a random-access memory (RAM), a read only memory (ROM), a storage of distributed computing systems, an optical disk (such as a compact disc (CD), digital versatile disc (DVD), or Blu-ray Disc (BD)™), a flash memory device, a memory card, and the like.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2017-072080, filed Mar. 31, 2017, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. A printing apparatus comprising:

a transfer drum configured to rotate while supporting a plurality of transfer members on each of which an image is formed by discharging ink from a printhead;

a rotating member configured to apply a processing liquid while being pressed against each of the plurality of transfer members;

a concave portion formed lower than a surface of each of the plurality of transfer members between adjacent transfer members; and

a driving unit configured to driven-rotate the rotating member in accordance with rotation of the transfer drum in a state in which the rotating member is pressed against the plurality of transfer members, and to driving-rotate the rotating member in a state in which the rotating member faces the concave portion.

2. The apparatus according to claim **1**, wherein the rotating member comprises a processing roller configured to apply the processing liquid onto each of the plurality of transfer members before the printhead discharges ink.

3. The apparatus according to claim **2**, wherein the driving unit includes:

a driving source; and

a one-way clutch configured to transmit a driving force of the driving source to the processing roller, and

wherein a rotation speed of the processing roller produced by the driving source is a speed that makes a peripheral speed of the processing roller lower than a peripheral speed of the plurality of transfer members.

4. The apparatus according to claim **2**, further comprising a restriction unit configured to restrict movement of the processing roller in a direction to enter the concave portion,

wherein the processing roller is supported to be movable to be close to/away from the surface, and

wherein the restriction unit releasably fixes a position of the processing roller.

5. The apparatus according to claim **2**, further comprising:

a reservoir unit configured to store the processing liquid; and

a supply roller having a portion which is dipped in liquid stored in the reservoir unit and configured to supply the liquid to the processing roller while being pressed against the processing roller.

6. The apparatus according to claim **5**, further comprising:

a restriction unit configured to restrict movement of the processing roller in a direction to enter the concave portion;

a support unit configured to support the reservoir unit, the processing roller, and the supply roller; and

a guide unit configured to guide movement of the support unit with respect to a direction in which the processing roller moves close to/away from the surface,

wherein the restriction unit releasably fixes a position of the support unit.

7. The apparatus according to claim **6**, further comprising an actuator configured to move the support unit.

8. The apparatus according to claim **6**, wherein the reservoir unit and the supply roller are supported by the support unit to be movable with respect to a direction in which the supply roller moves close to/away from the processing roller.

9. The apparatus according to claim **8**, further comprising an actuator configured to move the reservoir unit and the supply roller.

10. The apparatus according to claim **1**, wherein a plurality of concave portions, in which ends of the plurality of transfer members are held, are formed in an outer peripheral portion of the transfer drum.

11. A control method for a printing apparatus, the printing apparatus including a transfer drum configured to rotate while supporting a plurality of transfer members on each of which an image is formed by discharging ink from a printhead, a rotating member configured to apply a processing liquid while being pressed against each of the plurality of transfer members, and a concave portion formed lower than a surface of each of the plurality of transfer members between adjacent transfer members, the method comprising:

driven-rotating the rotating member in accordance with rotation of the transfer drum in a state in which the rotating member is pressed against the plurality of transfer members; and

driving-rotating the rotating member in a state in which the rotating member faces the concave portion.

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